MENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	17 Jan 91	THESIS/DISSERTATION

4. TITLE AND SUBTITLE
Characterization of Allergen Exposure in Homes

5. FUNDING NUMBERS

6. AUTHOR(S)
Debye Galaska, Captain

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AFIT Student Attending: John Hopkins University

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/CI/CIA- 91-009

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFIT/CI
Wright-Patterson AFB OH 45433-6583

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release IAW 190-1
Distributed Unlimited
ERNEST A. HAYGOOD, 1st Lt, USAF
Executive Officer

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

14. SUBJECT TERMS	15. NUMBER OF PAGES 13.7
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

CHARACTERIZATION OF ALLERGEN EXPOSURE IN HOMES

by

Debye Galaska, CIH

Essay

Submitted in partial fulfillment of the requirements
for the degree of Master of Health Science
at the Johns Hopkins University
School of Hygiene and Public Health

Baltimore, Maryland

17 Jan 91

A-1

ABSTRACT

Environmental sampling for allergen quantification is a relatively new field of endeavor. Current evaluations focus on surface sampling with vacuum devices using a variety of collection filters. In the allergy field, results have conventionally been reported in terms of a mass of antigen per a mass of "total dust" which varies in definition between analytical laboratories. Many of the sample protocols encourage composite sampling of many potential allergen sources to characterize an entire house.

Allergen levels were measured in 41 surface samples, and units of surface concentration of mass of antigen per total sieved dust, mass of antigen per unit area, and mass of antigen per unit area times sample collection time were compared. For dust mite antigen Der f 1 there was low correlation between units of surface concentration. Correlation between units for cat antigen Fel d 1 was strong. However, the more conventional unit of mass of antigen per unit area is demonstrated to be a more meaningful measure of reservoir potency. The impact of collection time and the appropriate way to incorporate it into measurements requires further study.

This study shows that there is a significant difference between antigen content of various reservoirs, such as carpets, sofas or chairs, and mattresses. There is also evidence to suggest that sample collection time, surface characteristics, and food sources should be explored further to establish whether they impact allergen levels.

Air samples were collected and compared to surface sample results. There was no correlation between surface levels of Fel d 1 and airborne levels. All but one of the results for Der f 1 air samples were below the limit of detection, indicating only that very large volumes, in excess of 22 cubic meters, are required to achieve detectable levels by present analytical methods.

ACKNOWLEDGEMENTS

I would like to thank Dr Robert G. Hamilton of the Johns Hopkins University Dermatology, Allergy and Clinical Immunology (DACI) Reference Laboratory and his staff for their assistance and analytical support; Professors Patrick Breysse and Peter SJ Lees for their guidance and suggestions; the gracious homeowners for their cooperation in submitting their homes to sampling procedures; and, mostly, my husband and children for their overwhelming support without which this work would not have been possible.

CONTENTS

TABLES

I. Introduction.

Allergy is a significant health problem for millions of Americans; with an estimated 35.3 million people affected in 1975.[1] Allergy complaints were second to dental conditions as the most frequent medical complaint.[1] Dust mite and cat allergies are common and result in symptoms year-round. Important allergens are those that efficiently deposit in the naso-pharyngeal region, where the immune system can recognize them and trigger a response.[2] Therefore, in assessing patient risks and the efficacy of protective measures, it is important to quantify the amount of airborne allergen that may reach the patient's naso-pharynx resulting in an allergic response.

The purpose of this research was to evaluate surface and air sampling methods available for quantifying dust mite and cat dander allergens in home environments. Vacuum sampling of household surfaces is currently used to assess the magnitude of exposure to allergens in the home.[3,4,5] Exposure is typically reported as the mass of allergen per mass of total household dust in a given sample. Exposure is then classified in broad categories as a high, medium or low risk factor.[4] It is not always clear exactly what the total dust represents. In some cases it is not total dust but the fraction that is scraped from the sample collection medium and sieved.

This project evaluates an air sampling method used in conjunction with a currently utilized surface sampling method to determine whether the vacuum sampling technique gives a reliable indication of inhalation exposure potential. Hypotheses tested include:

1. Surface samples as reported in nanograms of allergen per gram of total dust (ng/g) do not correlate with airborne allergen and, therefore, do not predict inhalation risks.

2. Surface samples as reported in ng/g do not correlate with surface

samples results in more conventional surface sampling terms of mass of allergen per unit area.

3. Surface sample collection time, using current sampling protocols, is important to consider in evaluating surface sample results.

4. Factors such as food consumption, type of surface (sofa, chair, mattress, etc), qualitative characteristics of the surface (loose or tight weave, deep or short pile, etc), level of activity, and time since a pet was last in the room may affect allergen levels in the surface and/or in the air.

II. Background.

A. The Nature of the Allergens. In this study the two major year-round allergens are evaluated, house dust mite and cat allergens. The major house dust mites producing allergens are Dermatophagoides farinae (Der f) and Dermatophagoides pteronyssinus (Der p). In particular, the allergens analysed for are referred to as Der f I and Der p I. The major cat allergen is referred to as Fel d I.

1. House-Dust Mite.

House dust is a complex mixture which contains a number of potential allergens, including house dust mites (living, dead, parts, and excreta), animal products (danders, saliva, and other proteins), fungi, algae, human skin scales, food debris, and decaying plant fibers.[1] In 1964 the house dust mite was identified by Voorhorst et al as the most important allergenic source within the generic house dust mixture.[6] Dust mite allergens have been associated causatively with asthma, atopic dermatitis, and rhinitis.[7] Studies from several countries, reviewed by Platts-Mills et al, demonstrate that asthmatic individuals have a higher prevalence of dust mite sensitivity than do non-asthmatics (45 to 85% prevalence as compared to 5 to 30% in controls). The reviewers interpret these consistent findings as a strong indicator that dust mite allergy is a risk factor for

asthma.[7] Thus, there has been a keen interest in characterizing the exposure levels found in various settings, quantifying and assessing potential risk from various exposure situations, and determining ways to reduce the risks.

The house mite was first identified by van Leeuwenhoek in 1694; since then over 50,000 species of mites have been identified.[1] The house dust mite has a three month life cycle, going through egg, larval, protonymph, tritonymph, and adult stages.[8,9] The Pyroglychoid family and, in particular, members of the the genus Dermatophagoides have been identified as a constituent of house dust by Baker in 1954. Specifically D. farinae and D. pteronyssinus are implicated as major sources of allergens, although others may be allergenically important to a lesser degree.[1]

Tovey et al[34] attempted to isolate the component of the dust mite which contains the allergen. They characterized mite allergic activity by quantifying Der p 1 (Dermatophagoides pteronnysinus 1), an antigen with molecular weight of 24,000 Daltons. Der p 1 is a major allergen by virtue of the fact that up to 75% of immunoglobulin E (IgE) antibodies to mites have been found to be directed against it. Tovey et al separated these components of a mite culture and analyzed them for antigen. Eggs were found to contain very little Der p 1, but whole mites, their feces and cuticles contained 3 to 185 nanograms (ng) of Der p 1 per 100 components (3 to 12, 29, and 75 to 185 for feces, cuticles, and whole mites respectively). From these data, the investigators calculated, by assuming a mite produces 20 fecal particles per day and sheds 3 cuticles over a three month lifetime, that, within a month, feces would have generated over 95% of Der p 1 present in culture. Additionally, the nature of the allergic response requires that the important allergenic components would have to elutriate rapidly in saline solution, because particles in the nasal mucosa would be cleared within 10 minutes of deposition.[9] Whole mite bodies do not

elutriate in a 16 hour period, whereas feces, mite culture, and house dust elutriate nearly 100% within 3 to 10 minutes. Fecal particles are numerous; they are spheroid, smooth surfaced particles ranging from 10 to 40 micrometers (um) in diameter; and they elutriate rapidly in saline; therefore, they are thought to be the most significant component.[9]

There are numerous conflicting views of where dust mites prefer to live.[1,7,8,10] Most authors agree that optimal proliferation conditions include high humidity, although the specific "best" humidity varies by source. Table 1 lists the relative humidity conditions for mite growth reported in the literature.

TABLE 1
IDEAL RELATIVE HUMIDITY FOR MITE GROWTH

Author	Ideal Relative Humidity(RH)
Wedner[1]	more than 75%
Kang[10]	75 to 80% RH (with almost no live mites below 40% RH)
Kaplan[8]	RH over 70% (no egg laying below 60%)

Some authors state that there is an ideal temperature range, listed in Table 2, for mite growth.

TABLE 2
IDEAL TEMPERATURE FOR MITE GROWTH

Author	Ideal Temperature
Platts-Mills[7]	17 to 25^{o} C
Wedner[1]	22 to 30^{o} C
Kaplan[8]	above 25^{o} C
Kang[10]	optimum of 25^{o} C

While the exact optimum temperature and humidity are difficult to

specify precisely, there is general agreement on a need for local warmth and moisture for some portion of the year. Short periods of dryness can be survived, as evidenced by studies of seasonal variation of mite populations. Tilak reports observing a higher population in the rainy season versus the dry season in India[11]. Platts-Mills et al observed a 5 to 20 fold increase in dust mite populations with rising humidity in Virginia.[12] A study in Ohio by Arlian et al showed highest mite density in humid summer months and lowest density in the dry heating season[13]. Murray and Zuk found a significant correlation between number of live mites and relative humidity in Vancouver, Canada[14]. Further, Mosbech et al conducted a controlled study using electric heating blankets as a potential control measure for at least 12 hours per day to decrease the local relative humidity. This study showed a median reduction in mite concentration of 60% in mattresses which were infested at the beginning of the study.[15] Korsgaard lists several other studies showing the influence of humidity on mite populations.[16]

A food source is also required for mite proliferation. The principal food source for house dust mites is thought to be human dander, with secondary sources including animal or bird dander, grain or other food dust, pollen, and fungal spores.[1] Van Bronswijk found pollen, spores of microorganisms, fungal mycelia, bacteria and fibers of plant origin (speculated to be from cotton bed sheets) in the alimentary canals of several hundred D. pteronyssinus mites, concluding that dependence on human skin scales is not as strong as other investigators have asserted.[17]

Carpets, upholstered furniture, and mattresses are generally found to be the major reservoirs of dust mites and/or mite antigens. There is no consistency between studies as to rank order of these major reservoirs. This is due in part to the different methods of determining the mite concentrations. Some investigators counted mite bodies from dust samples, and some performed analysis of dust samples for allergen quantity. There

are also variations between furnishings, carpeting, air conditioning, and other factors that could account for lack of a consistent ranking.

Tovey et al found bed dust (mattresses and bedding) to be the richest reservoir, with significant populations also present in carpets, furnishings, clothing and soft toys. They did not find populations on hospital and school floors (presumably uncarpeted, frequently washed surfaces).[4] Platts-Mills et al found in their central Virginia study that sofas harbored the largest Der p 1 reservoirs, followed by bedding, then carpets. The authors suggest that a difference in air conditioning, and thus in humidity, in different rooms may be the true explanation for higher sofa content in this study.[12] Arlian et al found, in most of the homes studied, that the highest mite populations were on the family room carpet, followed by family room couch, bedroom carpet, and lastly the mattress. Long pile carpets were found to be the most heavily infested flooring, with short pile carpets and tile or wood floors having significantly lower mite populations. A wide variation within homes, indicating that sampling at several sites within a home may be required before determining whether the home is low risk for those with mite allergies, was also noted.[13] Chang, studying homes in Taiwan, found mite populations in couches, mattresses, or bedroom or livingroom carpets did not differ.[18] Van Bronswijk studied cottages in The Netherlands occupied by asthmatic children, and inferred that mattresses and fabric covered furniture act as reservoirs for dust mites, from which floors can be reinfested periodically.[17] Study cottages were not carpeted, however.[17]

Platts-Mills et al assert that mites move away from the surface of furniture as drying occurs, so that the number of live mites counted in a surface sample may not be indicative of the quantity of allergen in the surface dust.[12] In contrast, van Bronswijk studied a mattress in cross section that was used for 12 years and found that dust had penetrated only

12 millimeters (mm) in the center and 6 mm at the sides. He alleges that the mites live only in the surface layer of the mattress.[17] This is the only published evaluation a mite reservoir in cross-section to see how far the infestation penetrated.

The Dermatophagoides family have a few natural predators, which include the arthropods Cheyletidae and Gamasina. These two have been found in conjunction with Dermatophagoides during surface sampling for whole arthropods.[17, 19] Few studies have actually looked for these predators to determine whether they significantly alter the Dermatophagoides populations, however.

It can be concluded, therefore, that the extent of dust mite infestation is likely to be due to many factors including characteristics of furnishings and floor coverings, temperature, humidity, and the presence of a food source.

2. Cat Allergens.

Cat allergen 1 (Fel d 1) is thought to be most often involved in human allergy.[20] Cat albumin and cat saliva also elicit allergenic activity, but to a lesser degree.[20]

Cat allergen generation is more clearcut than for dust mite allergen. The source is obvious; however, important observations about accumulation of the allergens can be made.

Ohman et al collected surface samples throughout homes with cats and attempted to correlate observed concentrations to patterns of cat occupancy. They found higher concentration of cat allergen in areas where cats spend the most time. However, areas from which cats were totally excluded contained measurable quantities of cat allergen, indicating that allergen can be carried around on persons and/or spread through air currents. Also of considerable interest is the observation that areas of frequent cat occupancy, such as sleeping areas on rugs or furniture, contained many

times the amount of allergen that could be washed off a cat (6300 to 20000 units on surface compared to 270 units washed off a single cat). This indicates that cat allergen progressively accumulates in some surfaces. The authors point out that Fel d 1 is very stable, and could remain in the environment for long periods of time, maintaining allergenic potency.[21]

The persistence of Fel d 1 in home environments is further corroborated in a controlled study by Wood et al in which cats were removed from several homes and surface samples were collected over a several month period. In homes where a cat was removed, the median Fel d 1 content declined to the upper 95% confidence limit of the control homes without cats at 23 weeks after cat removal (with regular vacuuming and routine cleaning).[22] In another study of 106 homes in the Baltimore area, 100% of homes had detectable cat allergen. In homes without cats in residence the levels ranged from 2 to 7500 nanograms per gram of dust (ng/g).[3]

B. Allergen Quantification.

Quantification of allergen in the environment is of interest for several reasons. First, there is interest in establishing whether a dose-response relationship exists between allergen exposure and the development of allergy symptoms. A clear dose-response relationship between allergen concentration and allergic response is asserted by Korsgaard. This controlled study showed a pattern of relative risks for allergic disease exceeding 1.0, when comparing higher to lower dust mite exposure categories. Much higher concentrations of house-dust mites were found in dust from the D pteronyssinus sensitive asthma patients' homes than in dust from control homes.[23] This finding has yet to be replicated, however.

Another use of precise allergen quantification would be for identifying sources of allergen and their relative contribution to potential risk. Quantification would also allow valid comparisons in assessing

avoidance type control measures, such as removing carpeting or other suspected reservoirs, frequent vacuuming, removing cats, etc.

Due to the difficulties in quantifying airborne allergen concentrations, surface sample collection techniques have been developed. Such results may be reported as a number of live and/or dead mites per mass of collected dust or as a mass of allergen per mass of collected dust. Complicating comparisons between studies looking to find a dose-response relationship, is the plethora of different analytical methods used to quantify allergen content, the variety of surface dust collection methods, the variable nature of the denominator portion of the concentration reported (usually total dust), and the unanswered question of whether a surface sample accurately describes the potential dose.

To illustrate, a study by Ishii et al demonstrated that the average number of mites in floor dust in homes of children in Tokyo did not differ between asthmatic and non-asthmatic children when compared on a mites per gram of dust basis, but did differ significantly between skin test positive and negative children when compared as mites per square meter of floor.[19] Another study,[3] of 106 homes in Baltimore, using mite antigen and cat allergen quantification in terms of ng/g of total dust, found no difference between homes of skin-positive and skin-negative patients or between homes with and without asthmatics.[3] Chang and Hsieh studied homes in Taiwan reporting surface concentration in terms of mites per mass of dust. This study also showed no difference between houses of "normals" and mite-allergic asthmatics. Additionally, they found no relation between the number of mites in the dust and the allergenicity of the dust.[18]

Platts-Mills et al proposed a broad categorization of dust mite allergen concentration in terms of ng/g of total dust, stating that 10,000 ng/g of Der p 1 is commonly associated with symptoms in mite-allergic persons, and that these levels be regarded as "high". Further breakdowns include:

levels between 2000 and 10000 ng/g should be considered as "significant"; levels below 2000 ng/g, as "low"; and levels below 400 ng/g, as "very low". [3,12]

Studies which have sought to define a possible dose-response relationship between allergen exposure and various allergic responses are fraught with difficulties in interpretation due to the wide variety of allergen quantification methods. Conclusions about whether past studies have either suggested or negated a dose-response relationship are therefore difficult to draw.

C. Previous Air Sampling Studies.

There are very few published dust mite and cat allergen air sampling studies. The American Conference of Governmental Industrial Hygienists guidebook on air sampling instruments refers to sampling methods for aero-allergens as at a "research level" due to the difficulty of sample analysis. Large air sample volumes are needed due to the low levels of airborne antigen generally present. Concentrations tend to vary logarithmically both spacially and temporally.[24] There are two basic analytical methods for allergen quantification: microscopic identification and counting, and immunological assay techniques. Six air sampling studies in the published literature are discussed below.

1. Tovey et al studied airborne antigens in asthmatic patients' homes, collecting dust on glass fiber filters using flow rates of 17 liters per minute (lpm) for short term sampling and 3.4 lpm for longer overnight sampling. A cascade impactor operated at 17.5 lpm was also used for size selective sampling. Dust extracts were analyzed by double antibody inhibition radioimmunoassay. Air sample filters were eluted in a glass tube prior to analysis.

Dust mite antigen was not detected under undisturbed conditions in the two hour or overnight samples. The only time Der p 1 allergen was detected

was when the rooms were actively disturbed with activities such as bed-making, shaking each piece of bedding, and vacuuming the bedding, mattress and floor. Disturbed condition sample periods were 45 minutes in length at 17 lpm. Airborne concentrations ranged from less than 0.392 to 39.22 ng/m^3, with most being in the 1.31 to 5.23 ng/m^3 range. The authors noted little correlation between the allergen concentration in the air of disturbed rooms and the concentration of allergen on the floor or in bed dust. Surface dust concentrations were expressed as ng of allergen per gram of sieved dust. (Surface results were not available in terms of mass per unit time or area.)

Particle sizing was conducted using a cascade impactor. Seventy six to 100% of the Der p 1 mass was collected on the greater than 6 micron stage; up to 14%, on the 2 to 15 micron stage; and little or none detected (average 4.5%) on the smaller stages. Sample times were less than 10 minutes at a rate of 17.5 lpm.[4]

2. Sakaguchi et al collected air samples during disturbed and undisturbed conditions using 37 mm glass fiber filters at a flow rate of 6 lpm. Sampling periods during undisturbed conditions were from 109 to 124 hours, resulting in sample volumes of 39.2 to 44.6 m^3. Disturbed condition samples were collected during and after 5 to 10 minutes of bedmaking, for 40 minute periods. Filters were extracted on a shaker and in an overnight cooling, then centrifuged. The supernatant was lyopholized then reconstituted to achieve a lower limit of detection by concentrating the allergen. Allergens were measured by radioimmunoassay.

Undisturbed Der I (farinae and pteronyssinus) levels were between 0.0076 and 0.116 ng/m^3, with a geometric mean of 0.029 ng/m^3. During the disturbed condition sampling, levels increased approximately 1000 fold, to 7.9 to 265 ng/m^3. Floor allergen levels were computed as ng of allergen per gram of fine dust. There was no correlation between airborne concen-

trations and surface contamination on the quilts.[5]

3. Cunnington and Gregory collected air samples with a 15 cm diameter cyclone operated at intake velocities of 300 and 1900 cm/sec. Flow rates were 400 lpm and 3000 lpm. A series of daily samples were collected during bedmaking, including turning the mattress, and for 5 to 15 minutes afterward. These samples were examined microscopically, counting mite bodies. D. pteronyssinus mites were observed at 0.04 to 0.34 mites per cubic meter in bedrooms. None were detected in a hospital ward. A dramatic decrease in number of mites was noted after regular vacuuming of a mattress was performed. No surface concentration information is available.[25]

4. Air samples were collected by Swanson et al with polytetrafluoroethylene filters for 24 hour sample periods at 200 lpm. Surface samples were collcted directly after air sampling by vacuuming a standard surface area for a standard collection time. Air samples were incubated in wells. The wells were washed and two-site monoclonal antibody assays were conducted to analyze for antigen. Additional analyses were conducted with a two-site radioimmunoassay and RAST-inhibition assays to compare the methods. Rank order between the methods was consistent, but absolute results varied with the method, with the rabit polyclonal two-site assay yielding much higher values than other assays in settled dust, and the IgE RAST-inhibition asssay giving much higher values in airborne dust.

Air concentrations of Der p 1 were less than 0.4 to 63.6 pg/m^3. Der f 1 airborne levels ranged from less than 0.4 to 78.2 pg/m^3. The investigators concluded that air and surface dust concentrations correlated only for Der p 1 measured in the bedroom and mattress dust, where the correlation coefficient was 0.84. Other air versus dust correlation coefficients were 0.18 for Der p 1 in livingrooms, 0.37 for Der f 1 in bedrooms, and 0.06 for Der f 1 in livingrooms.

Fel d 1 cat allergen was also evaluated. Fel d 1 airborne levels in the bedroom air correlated with the livingroom airborne levels, but not with surface dust concentrations. There was also a correlation between airborne mite and cat allergen concentrations, indicating, according to the authors, a common dependence on ventilation rates. Fel d 1 levels ranged from none detected to 345 pg/m^3, averaging 198 pg/m^3 in bedrooms and 163 pg/m^3.[26]

5. Swanson et al collected airborne allergen samples using glass fiber filters and a flow rate of 180 lpm. Total dust samplers collected for 24 to 72 hours, for a sample volume of 260 to 780 m^3. An Andersen cascade impactor, used for particle sizing, sampled for 48 hours collecting a volume of 3400 m^3. Filters were elutriated in buffer solution. Where low concentrations of allergen were present or the larger cascade impactor filter were used, the eluate was lyopholized and reconstituted. Plate-RAST inhibition assays were done to immunochemically measure antigen.

Airborne concentrations of cat allergen were found to be proportional to the number of cats in residence, and ranged from none detected to 92 ng/m^3. Airborne mite allergen (Der f) concentrations were measured from none detected to 5.57 ng/m^3. Airborne levels of both cat and mite antigens were consistent throughout different rooms within a home, and both levels increased dramatically during bedmaking (to 82 ng/m^3 for mite and 9,262 ng/m^3 for cat).

Cat and mite allergen particle sizes were within the respirable range, with mite particle sizes between 0.8 and 4.1 microns predominating in both disturbed and undisturbed air. In disturbed air cat allergen was most concentrated two size ranges, greater than 4.1 micron and smaller than 0.8 um. Cat allergen was more evenly distributed in undisturbed air, with a preponderance in less than 0.8 um. Investigators could not ascertain

whether particle fragmentation during sampling influenced these findings.[27]

6. Platts-Mills et al collected air samples at 17 lpm using 3 cm glass fiber filters. Particle size sampling was also conducted using a cascade impactor in which the discs were coated with an agarose, borate-buffered saline, bovine serum albumin solution. Sampling was conducted in two enclosed rooms, into which dust containing Der p 1 was artificially introduced. Antigen was measured by inhibition radioimmunoassay.

Vacuum cleaner bag dust containing antigen concentrations of 13,000 to 200,000 ng/g were aerosolized in the rooms either by manual disturbance or using a vacuum cleaner without a filter.

Experiments were conducted to evaluate the particle size distribution of mite allergen in the air and the decrease in airborne concentration after a disturbance. Results indicate that less than 4% (mass) of allergen remained airborne 15 to 35 minutes after the disturbance was created. The largest proportion of the allergen mass was collected on first stage, >10 um, although material was present in detectable levels down to the fourth stage, 0.3 to 2.5 um.[28]

The artificial dust generation system may biased the findings of Platts-Mills et al, however. The vacuum cleaner bag, used as the dust source, may not collect ultrafine particles very efficiently, and may not release them as efficiently as larger particles. Therefore, the smaller particles may have been selected out of the source. The authors also do not note that while the largest mass of particles was collected on the largest size stage, this does not reflect that smaller masses on smaller stages may contain larger numbers of particles. The numbers of particles, rather than the mass, may be important for initiation of allergic response. Additionally, there is a large disparity between the mass collected in the impactor and the mass collected on parallel filters that is not explained.

III. Methods.

A. Description of Sample Sites.

Homes were selected for airborne and surface antigen sampling based on the ease of access by the investigator. Each sample home required extensive sampling and therefore required cooperation of the homeowner. A description of each sample home is at Appendix 1.

B. Surface Sample Collection and Analysis.

Surfaces which are likely to be reservoirs for the antigens under study were initially investigated to identify homes with elevated surface antigen levels. Surfaces sampled include carpets, mattresses, upholstered furniture, and pillows. Homes with elevated surface antigen levels were re-visited to evaluate airborne antigen concentrations.

The surface samples were collected using a vacuum cleaner equipped with a vacuum sampling head provided by the Johns Hopkins Medical Institutions Reference Laboratory for Dermatology, Allergy & Clinical Immunology (DACI) analytical laboratory. The same vacuum cleaner, a Eureka cannister, was used each time with a fresh empty bag and unused filter. The sampler is an upholstery type attachment with a Whatman paper filter, pore size 11 um, placed inside a perforated plastic petri dish.

Samples were vacuumed from surfaces of known area for a known time period, with sample area and duration estimated in order to collect enough dust for an easily analyzed sample and completely cover the surface within the chosen boundaries. Previous experience of the laboratory analyzing these samples indicated that an 8 minute vacuum sample will generally provide sufficient mass for analysis. Collection times of 8 minutes, where feasible, were therefore employed. The vacuum attachment was moved slowly in close contact with the surface being sampled. The attachment was inverted at the conclusion of sampling to prevent loose material, and a labelled cover was placed on the petri dish. The dish was immediately

enclosed in a small zip-lock plastic type bag. Sample collection information was recorded on the Vacuum Sample Form (Appendix 2) and the sample was transmitted to the laboratory for analysis.

Analysis was conducted by the DACI Laboratory of the Johns Hopkins Medical Institutions. Collected material was scraped from the filter and forced through a 50 mesh sieve onto weighing paper. The dust was then weighed to the nearest milligram. One hundred mg of the sieved dust was transferred to a vial for analysis. Following the procedure described by Chapman et al,[29] samples were extracted overnight in 2 ml of borate-buffered saline and centrifuged. The supernatant is analyzed for allergen content.

Der f 1 and Der p 1 antigen enzyme immunoassays were conducted using procedures described by Chapman.[30,31] The sample is placed into microtiter wells containing a buffer solution and known amount of monoclonal antibody. Enzymatic reactions are stopped by addition of sodium azide, and results are evaluated in an ELISA microtiter plate reader. Standard dilutions of 1:5, 1:25 and 1:125 are used, and followed by higher dilutions if necessary. Results are reported in nanograms of antigen per gram of sieved dust (ng/g).

Fel d 1 cat allergen is extracted and analyzed using a similar technique with a monoclonal antibody procedure described by Chapman et al[32,33] Sample is added to microtiter wells containing buffer solution and a known amount of antibody. An ELISA microtiter plate reader is used to obtain results at at least two dilutions.

C. Air Sample Collection and Analysis.

Air samples were collected using a high volume vacuum pump, critical orifice, and 37 mm glass fiber filters in a closed face cassette. The filters were removed from the cassettes after sampling, rolled with the

collected dust to the interior, and placed into the analysis vial with tweezers. This enabled the use of less elutriant.

Initially a few 24-hour samples were collected at a flow rate of 14.75 lpm to determine the minimum sample volume needed to provide sufficient antigen for analysis. Detectable quantities of Der f 1 and Fel d 1, were observed in the samples, even where surface samples from the same area were low. It was therefore concluded that, where possible, 24-hour samples should be collected, yielding sample volumes around 10 m^3. In some situations, high activity levels or excessive pump noise necessitated shorter sample periods. Air sample collection parameters were recorded on the Air Sampling Form at Appendix 3.

The limit of detection on air sample filters, using a slightly modified analytical technique from that used for surface sample dust to increase sensitivity, is estimated to be approximately 0.4 nanograms of antigen per filter.

D. Evaluation of Homogeneity of Collected Surface Dust.

The variability of antigen levels within a previously characterized surface dust sample was evaluated. It was thought that, if sufficiently homogenous, this material could be used as a "known" antigen source to evaluate air sample analytical procedures. A bulk dust, collected from a vacuum cleaner bag, was analyzed by the DACI Laboratory and found to contain 914 ng/g of Der f 1. In the laboratory, this bulk sample was deposited onto two air sample filters by dropping a quantity of the characterized dust onto glass fiber filters while a pump was drawing air through the filter. These samples are referred to as spiked filter samples. The sample cassette was rotated and gently agitated to evenly disperse the dust. Sufficient quantities were added to provide antigen levels in excess of the reported quantification limits.

During this procedure the larger grains of dust, plainly visible, did

not adhere to the filter. The bulk dust was then placed in a Number 70 (212 micron opening) sieve and shaker to further separate larger particles from smaller. Two bulk samples of the larger dust, and three of the smaller dust from different parts of the samples were submitted to the DACI Laboratory for bulk analysis.

The sieved (<212 um) dust was then collected onto three air samples in the manner already described, and submitted to the DACI Laboratory for analysis.

IV. Results and Discussion.

A. Evaluation of Homogeneity of Collected Surface Dust.

The purpose of this evaluation is to see if a relatively homogeneous bulk sample could be obtained and used to evaulate analytical procedures by spiking samples with known quantities of allergen. The sieved bulk dust sample was originally analyzed by DACI with one sample and reported to contain 914 ng/g of Der f 1. The observation was made during the air sample test that the bulk dust did not all adhere to the filter. Therefore, the dust was sieved further, and the two fractions were studied.

The finer, sieved bulk dust was sampled three times, and sent blind to the analytical laboratory, to determine the homogeneity of the sample. Analysis of the sieved bulk dust that was believed to be homogenous showed variation between samples with a mean of 942 ng/g Der f 1, standard deviation of 260 ng/g, and range of 612 to 1247 ng/g. Results for the three samples of sieved dust (<212 um)are reported in Table 3, in nanograms per gram. Analysis for three antigens was provided by the laboratory, and are included for the information offerred about variability in other antigens.

TABLE 3

PREVIOUSLY CHARACTERIZED BULK DUST - AFTER SIEVING THROUGH NO 70 SIEVE

Sample Number	Der p 1	Der f 1	Fel d 1
R	<50	1247	110
S	<50	612	60
T	<50	968	210
Mean	<50	942	127
S.D.	0	260	62

The coarser bulk dust, >212 um, was sampled twice. There was no antigen detected in either sample (<50 ng/g for Der f 1, Der p 1, and Fel d 1), indicating that all of the antigen is present in the finer sieved dust.

These results indicate that there is variation within what is treated as homogenous dust, that there is variation in results from the analytical method when submitted in blind samples, or both. The sieve used by the DACI laboratory leaves coarse dust in the sample which increases the mass of dust in the denominator of concentration expressions, but this dust does not appear to contain antigen, nor to be related to antigen level. This bulkier dust visually appears to be sand or similar material which could be brought into the home environment independently of antigen.

The second portion of examining the analytical method involved loading air sample filters with a known concentration of bulk dust to determine whether there is a similar concentration finding on an air sample compared to the source bulk dust.

Filter samples from the original mixed dust were expected to contain 914 ng/g of Der f 1, within lab handling and extraction variability, if the original bulk dust had both been homogenous and had adhered to the air

sample filter in the same ratio as found in the bulk material. Analysis of the spiked filter using the original bulk dust sample showed only an average of 476 ng/g on the filter, reported in Table 4. There was no Der p 1 detected.

TABLE 4

FILTER SAMPLES - ORIGINAL CHARACTERIZED BULK DUST (914 NG/G of DER F 1)

Sample Number	Mass of Collected Dust, ng	Der f 1		Fel d 1	
		mass,ng	conc,ng/g	mass,ng	conc,ng/g
F	10.023	5.2	519	0.6	60
I	8.085	3.5	433	<0.5	<62
Mean			476		
SD			43		

Spiked filter samples of the fine fraction of the sieved dust were expected to approximate the average levels found in the bulk samples, 942 ng/g and 127 ng/g of Der f 1 and Fel d 1 respectively. Much lower concentrations of Der f 1 were found on the spiked filter samples than were found in the original bulk samples, and levels of Fel d 1 expressed in ng/g were higher in the spiked filter samples. Spiked filter results are reported in Table 5. All Der p 1 results were less than 0.5 ng.

TABLE 5

SPIKED FILTER SAMPLES - DUST SIEVED THROUGH NO 70 SIEVE (<212 um)

Sample Number	Mass of Collected Dust, ng	Der f 1		Fel d 1	
		mass,ng	conc,ng/g	mass,ng	conc,ng/g
G	9.411	6.3	669	1.0	106
H	9.286	4.1	442	1.5	162
J	6.889	3.7	537	1.5	218
Mean			549		161
SD			93		46

These results indicate that the proportion of dust containing antigen on a spiked sample filter is not consistent with the proportion found in the source bulk dust. This proportion is approximately 58% for Der f 1, and 127% for Fel d 1 for this trial. Some of the variation may be due to sample losses in handling. The variability in Fel d 1 spiked filter results was much higher than in Der f 1 results, with coefficients of variation of 29% and 17% respectively. An additional conclusion is that surface antigen expressed as ng of antigen per gram of dust is not likely to provide a reliable indicator of what will be found in an air sample, even without the additional complexity of differential settling in the air. This area needs to be the focus of further research.

B. Residential Airborne and Surface Antigen Levels.

1. Vacuum Sample Results. Results are available for Der f 1, Der p 1, Fel d 1, and total dust for 41 samples. Samples were collected in 29 locations within 9 homes. Fourteen samples were collected in duplicate locations on different days. Six samples were determined by the analytical laboratory to have insufficient quantity for analysis.

The levels of the three antigens are reported follwing the DACI Laboratory convention, in nanograms of antigen per gram of total sieved dust. Fifty ng/g was the detection limit for the assays reported by the laboratory.

TABLE 6

VACUUM SAMPLE RESULTS
AS REPORTED BY DACI IN NG/G

Sample #	Der f 1	Der p 1	Fel d 1	Total Dust	Site
V001	767	163	97	0.328	A/BR1/futon
V013	1167	290	202	0.247	A/BR1/futon
V030*	371	278	152	0.148	A/BR1/futon
V002	1156	<50	57	0.245	A/BR1/carp
V003	118	59	997	0.227	A/BR2/futon
V029*	115	68	<50	0.145	A/BR2/futon
V004	116	<50	132	0.227	A/BR2/carp
V005	60	<50	563	0.621	A/LR/sofa
V028*	62	<50	1350	0.949	A/LR/sofa
V006	247	269	<50	0.063	A/LR/carpet
V007	<50	<50	157	0.159	A/BR3/futon
V008	<50	<50	557	0.179	A/BR3/carp
V009	54	<50	2,323,180	0.135	B/FR/chair
V010	70	<50	264,397	0.034	B/FR/carpet
V031*	213	<50	not enough	not given	B/FR/chair/r
V032*	59	<50	3,134,314	0.152	B/FR/chair/l
V011	318	592	3323	0.696	C/FR/sofa
V041*	1233	293	1051	0.3138	C/FR/sofa
V012	222	168	2281	0.099	C/FR/carpet
V042*	1657	92	461	0.2433	C/FR/carpet
V014	168	<50	97	0.338	D/BR/mattr
V037*	125	<50	514	0.040	D/BR/mattr
V015	175	<50	228	0.621	D/BR/carpet
V036*	190	<50	305	0.992	D/BR/carpet
V016	<50	<50	<50	0.886	E/LR/carpet
V017	<50	<50	207	0.083	E/LR/chairl
V018	373	<50	<50	0.322	E/LR/chair2
V035*	548	<50	<50	0.036	E/LR/chair
V019	836	<50	8,777,972	0.087	F/LR/chair
V020	5718	<50	1,830,677	0.024	F/LR/chair
V021	301	<50	613	0.068	G/LR/sofa
V044*	292	<50	298	0.4155	G/LR/sofa
V022	513	<50	229	1.302	G/LR/carpet
V023	208	<50	124	0.393	G/BR/rug
V024	205	<50	<50	0.020	G/BR/pillow
V025	20886	3882	57	0.219	H/FR/couch
V026	3183	2727	<50	0.034	H/FR/carpet
V027	201	523	<50	0.038	H/BR/bedding
V033	<50	<50	147,843	1.029	B/DR/carpet
V034*	<50	<50	114,042	0.372	B/DR/carpet

V038	not enough to analyze				I/BR/pillow
V039	976	61	<50	0.180	I/BR/matt
V040	not enough to analyze				I/BR/carpet
V043	not enough to analyze				
V045*	454	<50	<50	1.3827	G/LR/carpet
V046	not enough to analyze				
V047	not enough to analyze				

* denotes vacuum samples collected after air sampling.
House locations A-I are described in Appendix 1.
BR is bedroom, FR is family room, DR is dining room, LR is livingroom.

The total allergen in the sample was calculated, and this was used to determine surface antigen levels using units of ng/ft^2 and $ng/ft^2(min)$. These results are presented in Tables 7 - 9.

TABLE 7

VACUUM SAMPLE RESULTS FOR DER F 1
AS ANTIGEN PER GRAM OF SIEVED DUST, PER SAMPLE, PER TIME, AND PER AREA

Sample #	ng/g	ng/sample	ng/min	ng/ft^2	$ng/ft^2(min)$
V001	767	251.6	31.5	2.2	0.27
V002	1156	283.2	31.5	4.7	0.59
V003	118	26.8	3.8	1.4	0.203
V004	116	26.3	3.8	0.5	0.07
V005	60	37.3	7.5	1.0	0.20
V006	247	15.6	3.1	0.3	0.07
V007	<50	<8.0	<1.0	<0.2	<0.03
V008	<50	<9.0	<1.5	<0.2	<0.04
V009	54	7.3	1.2	0.4	0.07
V010	70	2.4	0.2	0.1	0.015
V011	318	221.3	26.0	9.6	1.13
V012	222	22.0	2.9	1.5	0.2
V013	1167	288.2	41.2	3.8	0.54
V014	168	56.8	12.6	6.0	1.33
V015	175	108.7	21.7	8.5	1.70
V016	<50	<44.3	<8.7	<3.6	<0.74
V017	<50	<4.2	<1.0	<0.5	<0.12
V018	373	120.1	24.0	18.8	3.75
V019	836	72.7	18.2	16.9	4.23
V020	5718	137.2	27.4	13.9	2.77
V021	301	20.5	4.1	1.6	0.32
V022	513	667.9	95.4	34.4	4.92
V023	208	81.7	11.7	6.4	0.91
V024	205	4.1	0.9	0.2	0.05
V025	20886	4574.0	571.8	205.1	25.64
V026	3183	108.2	27.1	9.1	2.27
V027	201	7.6	1.9	0.3	0.07

V028*	62	58.8	7.8	2.5	0.33
V029*	115	16.7	1.9	0.9	0.10
V030*	371	54.9	7.8	1.4	0.20
V032*	59	9.0	2.3	1.1	0.27
V033	<50	<51.5	<12.9	<8.6	<2.15
V034*	<50	<18.6	<4.1	<3.0	<0.68
V035*	548	19.7	2.8	3.1	0.44
V036*	190	188.5	37.7	20.9	4.19
V037*	125	5	0.8	0.3	0.05
V039	976	105.4	21.1	13.5	2.70
V041*	1233	386.9	43.0	34.2	3.80
V042*	1657	403.1	50.4	34.5	4.31
V044*	292	121.3	20.2	13.6	2.27
V045*	454	627.7	104.6	60.9	10.16

TABLE 8

VACUUM SAMPLES FOR DER P 1
AS ANTIGEN PER GRAM OF SIEVED DUST, PER SAMPLE, PER TIME, AND PER AREA

Sample #	ng/g	ng/sample	ng/min	ng/ft^2	$ng/ft^2(min)$
V001	163	53.3	6.7	0.5	0.06
V002	<50	<12.3	<1.5	<0.2	<0.03
V003	59	13.4	3.8	0.7	0.10
V004	<50	<11.4	<1.6	<0.2	<0.03
V005	<50	<31.1	<6.2	<0.8	<0.17
V006	269	16.9	3.4	0.4	0.07
V007	<50	<8.0	<1	<0.2	<0.03
V008	<50	<9.0	<1.5	<0.2	<0.04
V009	<50	<6.8	<1.1	<0.4	<0.07
V010	<50	<1.7	<0.2	<0.1	<0.01
V011	592	412.0	48.5	17.8	2.10
V012	168	16.6	2.2	1.1	0.15
V013	290	71.6	10.2	0.9	0.13
V014	<50	<16.9	<3.8	<1.8	<0.40
V015	<50	<31.1	<6.2	<2.4	<0.49
V016	<50	<44.3	<8.7	<3.6	<0.74
V017	<50	<4.2	<1.0	<0.5	<0.12
V018	<50	<16.1	<3.2	<2.5	<0.50
V019	<50	<4.4	<1.1	<1.0	<0.26
V020	<50	<1.2	<0.2	<0.1	<0.02
V021	<50	<3.4	<0.7	<0.3	<0.05
V022	<50	<65.1	<9.3	<3.4	<0.48
V023	<50	<19.7	<2.8	<1.5	<0.22
V024	<50	<1.0	<0.2	<0.05	<0.01
V025	3882	850.2	106.3	38.1	4.77
V026	2727	92.7	23.2	7.8	1.95
V027	523	19.9	5.0	0.8	0.19
V028*	<50	<47.5	<6.3	<2.0	<0.27
V029*	68	9.9	1.1	0.5	0.06
V030*	278	41.1	5.9	1.1	0.15
V032*	<50	<7.6	<1.9	<0.9	<0.23
V033	<50	<51.5	<12.9	<8.6	<2.15
V034*	<50	<18.6	<4.1	<3.0	<0.68
V035*	<50	<1.8	<0.3	<0.3	<0.04

V036*	<50	<49.6	<9.9	<5.5	<1.10
V037*	<50	<2	<0.3	<0.1	<0.02
V039	61	6.6	1.3	0.8	0.17
V041*	293	91.9	10.2	8.1	0.90
V042*	92	22.4	2.8	1.9	0.24
V044*	<50	<20.8	<3.5	<2.3	<0.39
V045*	<50	<69.1	<11.5	<6.7	<1.12

TABLE 9

VACUUM SAMPLES FOR FEL D 1
AS ANTIGEN PER GRAM OF SIEVED DUST, PER SAMPLE, PER TIME, AND PER AREA

Sample #	ng/g	ng/sample	ng/min	ng/ft^2	ng/ft^2(min)
V001	97	31.8	4.0	0.3	0.03
V002	57	14.0	1.8	0.2	0.03
V003	997	226.3	32.2	11.9	1.70
V004	132	30.0	4.3	0.6	0.08
V005	563	349.6	69.9	9.3	1.86
V006	<50	<3.2	<0.6	<0.1	<0.01
V007	157	25.0	3.1	0.7	0.08
V008	557	99.7	16.6	2.5	0.42
V009	2,323,180	313,629.3	52,271.6	18,340.9	3056.82
V010	264,397	8,989.5	899.0	266.0	26.60
V011	3323	2,312.8	272.1	100.1	11.78
V012	2281	225.8	30.1	15.5	2.06
V013	202	49.9	7.1	0.7	0.09
V014	97	32.8	7.3	3.5	0.77
V015	228	141.6	28.3	11.1	2.21
V016	<50	<44.3	<8.7	<3.6	<0.74
V017	207	17.2	4.3	2.0	0.49
V018	<50	<16.1	<3.2	<2.5	<0.50
V019	8,777,972	763,683.6	190,920.9	177,600.8	44,400.21
V020	1,830,677	43,936.2	8,787.2	4438.0	887.60
V021	613	41.7	8.3	3.2	0.64
V022	229	298.2	42.6	15.4	2.20
V023	124	48.7	7.0	3.8	0.54
V024	<50	<1.0	<0.2	<0.05	<0.01
V025	57	12.5	1.6	0.6	0.07
V026	<50	<1.7	<0.4	<0.1	<0.04
V027	<50	<1.9	<0.5	<0.1	<0.02
V028*	1350	1281.2	170.8	53.8	7.18
V029*	<50	<7.3	<0.8	<0.4	<0.04
V030*	152	22.5	3.2	0.6	0.08
V032*	3,134,314	476,415.7	119,103.9	58099.5	14524.87
V033	147,843	152,130.5	38,032.6	25355.1	6338.77
V034*	114,042	42,423.6	9,427.5	6954.7	1545.49
V035*	<50	<1.8	<0.3	<0.3	<0.04
V036*	305	302.6	60.5	33.6	6.72
V037*	514	20.6	3.4	1.1	0.19
V039	<50	<5.4	<1.1	<0.7	<0.14
V041*	1051	329.8	36.6	29.2	3.24
V042*	461	112.2	14.0	9.6	1.20

V044*	298	123.8	20.6	13.6	2.32
V045*	<50	<69.1	<11.5	<6.7	<1.12

There were several issues to examine concerning the vacuum sample results. The first issue relates to the selection of appropirate vacuum sample surface concentration terms. The concentration term used in the allergy field of ng of antigen per gram of sieved collected dust did not seem to be most appropriate for reasons already discussed in the analytical method section. The mass of dust in a given area does not appear to be a relevant or consistent denominator with which to characterize allergen concentration in a given source. The standard industrial hygiene concentration term for surface samples is to express them in terms of mass per unit area. This term offers the advantage of quantifying allergen within a defined space, so that predictions could be made regarding the consequences of disturbing a particular area. A third term was evaluated to attempt to take into account an important aspect of surface sampling by vacuum; the time of contact with the relatively complex surfaces of upholstery or carpet within a given area has an impact on how much antigen is collected. Increased time in an area will increase collection, within limits.

A total of 41 samples were collected with sufficient dust for analysis. The samples were collected by trying to evenly cover the surface area in one pass. Linear regression was performed to see if there was a relationship between sample area and collection time. The mean collection time in this set of samples was 6.2 $\pm$4 minutes. The mean collection area was 23.1 $\pm$ 4.3 ft^2. The collection time and area were weakly but significantly correlated ($r = 0.383$, $p<0.05$). Presence of a cat, surface type (carpet, sofa/chair, or mattress), and a subjective scalar rating of the trapping ability of a surface were all significant factors in this relationship. Other factors that were beyond the scope of this project may also affect the time required to sample a surface. (See Appendix 4.) This analysis indicates that it may be important to consider both the sample area and

collection time in evaluating the significance of vacuum sample results.

Histograms of Der f 1 and Fel d 1 surface sample results are presented in Appendix 5. Arithmetic and geometric means and standard deviations of the sample sets for the various concentration units studied are in Tables 10 and 11. The raw surface sample data, in all units, are very skewed; when logarithms are taken, the data appear to approximate a normal distribution. Fel d 1 data were clearly bimodally distributed. The presence or absence of a cat in the house was taken into account in further analyses.

TABLE 10

DER F 1 VACUUM SAMPLE CHARACTERISICS - 41 SAMPLES

Concentration Term	Arithmetic Mean	Arithmetic SE	Geometric Mean	Geometric SE
ng/g	1056	25	239.1	25.00
ng/filter	226.3	2.075	46.9	2.08
ng/ft^2	13.43	0.0704	2.78	0.070
ng/ft^2(min)	2.044	0.00704	0.466	0.00704

*For these presentations, values of 0.5 of the limit of detection were used for calculating means and standard deviations.

TABLE 11

FEL D 1 VACUUM SAMPLE CHARACTERISICS - 41 SAMPLES

AGGREGATE DATA - ALL HOMES

Concentration Term	Arithmetic Mean	Arithmetic SE	Geometric Mean	Geometric SE
ng/g	405042	25.00	665.81	25.00

DATA FOR HOMES WITH CAT PRESENT

Concentration Term	Arithmetic Mean	Arithmetic SE	Geometric Mean	Geometric SE
ng/filter	257316	8989	117008	8991
ng/sf	41579	266.0	12161	265.9
ng/sf*min	10111	26.60	2397.1	26.60

DATA FOR HOMES WITHOUT CATS

Concentration Term	Arithmetic Mean	Arithmetic SE	Geometric Mean	Geometric SE
ng/filter	183	1	32.14	0.5
ng/ft^2	10	0.0	1.697	0.025
ng/ft^2(min)	1	0.01	0.276	0.0055

The surface sample data were then examined for a relationship between antigen mass per sample and sieved dust per sample. Taking the logarithms of the antigen and dust quantities was necessary for performing linear regression; this resulted in more bell-shaped residuals.

For Der f 1 there was a significant, though not strong, relationship between the total sieved antigen and the total sieved dust collected on the filter ($r = 0.49$, $p<0.05$). Plots and statistics are in Appendix 6. This further strengthens the notion that there is no intrinsic relationship between the quantity of dust in a vacuum surface sample and the quantity of Der f 1 antigen. Clearly there is even less relationship for Der p 1, which had too many non-detectable results for good statistical analysis.

The 95% confidence limits of the regression slope for surface sample mass of Fel d 1 and corresponding total sieved dust overlapped zero, indicating no significant relationship, when no factors were present in the model. When the factor of cat presence or absence was added to the model, there was a significant relationship between the two quantities ($r=0.93$, $p<0.05$). See Appendix 7 for details of this statistical analysis.

Thus, the mass of dust present in a sample is not a reliable indicator of the amount of Fel d 1 allergen present, unless some accounting is made for the presence or absence of a cat. The mass of Der f 1 is weakly related to the mass of dust in the analyzed sample, and without further elucidation of other relevant factors is not a good predictor of allergen presence by itself.

Analyses of variance were conducted with surface sample Der f 1 results to tentatively explore the impact of some factors on the levels of antigen found in the 41 vacuum samples analyzed. There are a multitude of factors that may potentially impact the level of antigen present. A few pertinent factors were identified that are important to levels of antigen present. These include type of surface, the trapping ability of the surface for dust retention, consumption of food, and presence or absence of a cat in the home.

The type of surface was classified as carpet, sofa/ chair, or mattress. Whether the surface was carpet was a significant factor in this sample set. The mean for carpet was 21.52 ng/ft^2, with standard error 7.610 ng^2/ft^4, with means in sofa/chair of 9.342 ng/ft^2 and in mattress of 3.549 ng/ft^2. Carpets were also highest when units of ng/ft^2(min) were used. As discussed in the Background Section, different studies have had different findings as to the most potent reservoirs of allergen. Carpets contained the highest levels of Der f 1 in this study; beds, sofas, and carpets have each been identified as the most potent reservoir in various other studies. Therefore, there must be other factors, aside from the fact that the item studied is a carpet or bed or sofa, about the sources that make them preferential allergen reservoirs.

Areas where food consumption took place on more than a rare occasion (more than once a month) showed a statistically significant increase in Der f 1. This is consistent with previously cited studies which state that mites use both human dander and human foodstuffs as food sources. Surfaces were also subjectively rated on a scale of 1 to 3 as to their trapping ability. This assessment took into account parameters such as thickness of weave, depth of carpet pile, and thickness of underlying material if dust could readily penetrate to underlying material. High trapping ability (rating of 3) of a surface was significantly associated with higher levels

of antigen. In this particular group of sample sites, the highest antigen levels occurred where there was a trapping rating of 3 (highest), carpet, and food consumption more than once a month. The absence of a cat was also associated with higher Der f 1 levels. From discussion with the various residents, the cat-owners in this group seemed to vacuum more frequently than the non-pet owners. (See Appendix 8.)

Similar analyses of variance were conducted for Fel d 1 presence. In this sample set there was an overall trend for highest antigen level in the sofa/chair category, most likely because the cats in this study used chairs as their favorite napping location. Nearby carpet was consistently lower in antigen content, and the one carpet napping area was lower than the chairs. High trapping ability rating and presence of a cat interacted to also result in high Fel d 1 levels in this sample of sites. As expected, there was no relationship between cat allergen and the consumption of food by human occupants. See Appendix 9 for details of statistical analysis.

To additionally characterize the dust collected, the total Der f 1 collected on each filter was compared to total Fel d 1 collected on that filter. As expected, there was no correlation between dust mite and cat allergen, unless the presence or absence of a cat was added to the model. With that factor added, there was a weak but significant correlation ($r = 0.41$, $p<0.05$). See Appendix 10 for details of statistical analysis.

These results indicate that presence or absence of a cat must be taken into account when evaluating surface antigen quantity. Other factors which require more precise definition may also be important. It appears that food consumption and factors that make reservoirs attractive may be important to evaluate the allergenic potential of an environment. These factors may include microenvironment humidity, ability to trap warm air, introduction of human dander (perhaps with a yet to be determined minimal frequency), increased surface area due to roughness/ fibers/complexity, depth of

viability within the material (can a reservoir survive beneath where it is removed by vacuuming and ordinary movement), etc.

Several linear regressions were performed to determine whether a relationship exists between the laboratory reported antigen concentrations in terms of ng of antigen per gram of sieved dust and more conventional surface sampling concentration terms. Der p 1 data was not used for these analyses because there were so many results below the detection limit, and data from other allergens was more complete.

The conventioanl unit of the allergy field, ng/g, is compared to the traditional industrial hygiene standard sample unit of ng/unit area, in this case ng/ft^2. A hybrid unit of ng/ft^2(min) is also evaluated due to the obvious effect, within reasonable bounds, that increased collection time would have on the amount of both dust and allergen extracted from a surface. The exact nature of variation in collection time and the bounds of linearity have not been determined in this paper, but collection times were between 4 and 10 minutes and were believed not to have reached the "saturation point" by observation. Collection technique was attempted in such a way as to uniformly cover each surface with the vacuum attachment, which required moderate variation in speed of movement of the attachment.

For this analysis the Der f 1 and Fel d 1 results below the reported detection limit of 50 ng/g were not used. The logarithms of the antigen concentrations were used in the linear regressions for reasons already stated in previous analyses. There was a weak but significant correlation ($r = 0.666$, $p<0.05$) between Der f 1 in ng/g and Der f 1 in ng/sf*min. The factor of food consumption was significant in this analysis. Interactions between food and other factors were previously noted in the analyses of variance discussed above. Der f 1 in ng/sf correlated with units of ng/g with $r = 0.679$. In this analysis, food consumption was also significant.

See Appendix 11 for details of statistical analyses.

Correlation of Fel d 1 antigen in ng/g with the units of ng/sf and ng/sf*min were very strong with r = 0.94 for each ($p<0.05$). The presence or absence of a cat is the most significant factor. Whether the surface type was a sofa/chair was also significant, as noted previously. See Appendix 12 for details of statistical analyses.

2. Air Sample Results. Air samples were collected at various sites, using a vacuum pump, critical orifice, and 37 mm glass fiber filter in a closed-face cassette. Three blank samples were treated similarly to the air sample cassettes. They showed no detectable antigen. Table 12 gives results of air samples for Der f 1. All samples were none detected for Der p 1.

TABLE 12
AIR SAMPLE RESULTS FOR DER F 1

Sample Number	Volume (m^3)	Concentration (ng/m^3)	Activity	Location
A612	21.270	0.046	Moderate	A/BR/next to futon 24 hrs
A613	0.472	<1.059	High	B/LR/next to cat chair
A614	21.683	<0.023	Low	B/LR/next to cat chair
A615	22.420	<0.022	Mod	A/MBR/next to futon/sleep,vac
A616	38.512	<0.013	Low	A/LR/cassette on sofa
A617	21.314	<0.023	Moderate	A/BR2/head of child bed
A618	10.664	<0.047	Low	B/FR/next to cat chair
A619	21.255	<0.024	None	B/FR/right chair
A621	0.428	<1.1682	High	B/FR/vacuum sampling
A622	11.505	<0.043	Low	B/FR/Left easy chair
A623	9.735	<0.051	Low	B/FR/left chair
A624	20.488	<0.024	Moderate	B/DR/cat sleeping spot

A625	20.827	<0.024	Mod-Hi	E/LR/between chairs
A626	9.514	<0.053	Moderate	D/BR/head of bed
A628	21.314	<0.02	Moderate	C/FR/by sofa
A629A	21.240	<0.024	Moderate	G/LR/near sofa
A629B	20.945	<0.024	Moderate	F/LR/near cat chair

Note: LR is living room, FR is family room, BR is bedroom, DR is dining room.

Table 13 contains air sample results for cat allergen Fel d 1.

TABLE 13
AIR SAMPLE RESULTS FOR FEL D 1

Sample Number	Volume (m^3)	Concentration (ng/m^3)	Activity	Location
A612	21.270	0.029	Moderate	A/BR/next to futon 24 hrs
A613	0.472	61.441	High	B/LR/next to cat chair
A614	21.683	0.101	Low	B/LR/next to cat chair
A615	22.420	<0.022	Mod	A/MBR/next to futon/sleep,vac
A616	38.512	<0.013	Low	A/LR/cassette on sofa
A617	21.314	<0.023	Moderate	A/BR2/head of child bed
A618	10.664	<0.047	Low	B/FR/next to cat chair
A619	21.255	0.080	None	B/FR/right chair
A621	0.428	<1.1682	High	B/FR/vacuum sampling
A622	11.505	<0.043	Low	B/FR/Left easy chair
A623	9.735	<0.053	Low	B/FR/left chair
A624	20.488	0.054	Moderate	B/DR/cat sleeping spot
A625	20.827	<0.055	Mod-Hi	E/LR/between chairs
A626	9.514	<0.055	Moderate	D/BR/head of bed
A628	21.314	<0.018	Moderate	C/FR/by sofa
A629A	21.240	0.019	Moderate	G/LR/near sofa
A629B	20.945	0.019	Moderate	F/LR/near cat chair

An attempt was made to analyze the relationship between vacuum sample results and air sample results. Unfortunately, there was only one detectable air sample result for Der f 1, and it was at or below the detection limit of the remainder of the air samples. The only conclusion that can be drawn from this is that sample volumes in excess of 22000 liters are required to detect mite antigen in air samples.

There were seven detectable air samples for Fel d 1 antigen, out of a total of 17 air samples collected. A linear regression was conducted to determine if there was any relationship between surface sample antigen and airborne levels in the seven air samples that exceeded the limit of detection. There was no significant correlation between these two measures. Factors of presence or absence of a cat, and the activity level measure (scalar of 1 to 4 assigned as an indicator of the amount of mechanical disturbance of the surface during the sample period) were added in an analysis of covariance. These factors still did not make for a correlation between surface and airborne antigen level, even when a high activity level and presence of a cat were taken into account. See Appendix 13 for statistical analyses details.

From these limited data there appears to be no relationship between surface antigen levels and airborne levels for Fel d 1, even with the two factors most likely to influence this relationship accounted for.

V. Conclusions.

To summarize, the following conclusions are drawn:

1. Samples of household dust from one source may vary widely (± 28%) when submitted as blind samples. This could be due to variation within the dust source or variation in the analytical method.

2. Dust greater than 212 um did not contain antigen in a typical household dust sample, yet this dust would be considered in the denominator

as part of total dust in some antigen concentration expressions.

3. When loading air samples with a known concentration of antigen expressed as ng/g, the same ratio of ng of antigen to g of dust does not hold on the air sample filter. In the sample tested in this investigation, the amount of Der f 1 was much lower than expected, but the level of Fel d 1 was higher than expected. This indicates potential analytical biases may be present using current air sample filter allergen methods.

4. The impact of vacuum sample collection time requires further study.

5. Factors influencing antigen concentration in various reservoirs require further study to ascertain which are most important and the degree to which they impact surface antigen quantification.

6. A vacuum surface sample should be expressed in terms of ng per unit area, perhaps taking into account the sample collection time or volume.

7. Surface levels of Der f 1 expressed in ng/g do not correlate well with ng per unit area.

8. Surface sample levels of Fel d 1 expressed in ng/g correlate well with units of ng/ft^2 and with $ng/ft^2(min)$.

9. With the current air sample filter analytical method, air volumes in excess of 22 cubic meters are required to achieve detectable Der f 1 levels.

10. Based on limited data, there was no relationship between airborne and surface levels of Fel d 1, even with presence or absence of a cat and the activity level taken into account.

VI. REFERENCES

1. Korenblat PE, Wedner HJ (Editors). 1984. Allergy Theory and Practice, Grune & Stratton, Inc., Orlando, pp 7-39, 173-178, 181-182, and 371-375.

2. Lessof MH, Lee TH, Kemeny DM (editors). 1987. Allergy: An International Textbook, Williams & Wilkins, Baltimore, pp 1-7.

3. Wood RA, Eggleston PA, Lind P, Ingemann L, Schwartz B, Graveson S, Terry D, Wheeler B, Adkinson Jr NF. Antigenic Analysis of Household Dust Samples. Am Rev Respir Dis 1988; 137:358-363.

4. Tovey ER, Chapman MD, Wells CW, Platts-Mills TAE. The Distribution of Dust Mite Allergen in the Houses of Patients with Asthma. Am Rev Respir Dis 1981; 124:630-635.

5. Sakaguchi M, Inouye S, Yasueda H, Irie T, Yoshizawa S, Shida T. Measurement of Allergens Associated with Dust Mite Allergy. II. Concentrations of Airborne Mite Allergens (Der I and Der II) in the House. Int Arch Allergy Appl Immunol 1989; 90:190-193.

6. Voorhoost R, Spieksma FTM<, Varekamp H, Leupen MJ, Lyklema AW. The House-Dust Mite (Dermatophagoides pteronyssinus) and the Allergens it Produces. Identity with the House-Dust Allergen. Allergy 1967; 39 (6): 325-339.

7. Platts-Mills TAE, de Weck AL (chairmen). Dust Mite Allergens and Asthma - A Worldwide Problem. The Journal of Allergy and Clinical Immunology 1989; 83(2):416-427.

8. Kaplan AP (editor). 1985. Allergy, Churchill Livingstone, New York, pp 256-7, 287-89,292-4, and 323-331.

9. Tovey ER, Chapman MD, Platts-Mills TAE. Mite Faeces are a Major Source of House Dust Allergens. Nature 1981; 289:592-3.

10. Kang B, Chang JL. Allergenic Impact of Inhaled Arthropod Material. Clin Rev Allergy 1985; 3: 363-375.

11. Tilak ST, Jogdand SB. House Dust Mites. Annals of Allergy 1989;

63:392-397.

12. Platts-Mills TAE, Hayden ML, Chapman MD, Wilkins SR. Seasonal Variation in Dust Mite and Grass-Pollen Allergens in Dust from the Houses of Patients with Asthma. J Allergy Clin Immunol 1987; 79:781-791.

13. Arlian LG, Bernstein MD, Gallagher JS. The Prevalence of House Dust Mites, Dermatophagoides spp, and Associated Environmental Conditions in Homes in Ohio. J Allerhy Clin Immunol 1982; 69:527-532.

14. Murray AB, Zuk P. The Seasonal Variation in a Population of House Dust Mites in a North American City. J Allergy Clin Immunol 1979; 64(4):266-269.

15. Mosbech H, Korsgaard J, Lind P. Control of House Dust Mites by Electrical Heating Blankets. J Allergy Clin Immunol 1988; 81:706-710.

16. Korsgaard J. House-Dust Mites and Absolute Indoor Humidity. Allergy 1983; 38:93--102.

17. Van Bronswijk JEMH. Dermatophagoides Ptreonyssinus (Trouessart, 1897) in Mattress and Floor Dust in a Temperate Climate (Acari: Pyroglyphidae). J Med Ent 1973; 10(1):63-70.

18. Chang YC, Hsieh KH. The Study of House Dust Mites in Taiwan. Annals of Allergy 1989; 62:101-106.

19. Ishii A, Takaoka M, Kabasawa Y, Ouchi T. Mite Fauna and Fungal Flora in House Dust from Homes of Asthmatic Children. Allergy 1979; 34:379-387.

20. Stankus RP, Lehrer SB. Common Seasonal and Environmental Allergens. Postgraduate Medicine 1987; 82(5):213-221.

21. Ohman JL, Lorusso JR, Lewis S. Cat Allergen Content of Commercial House Dust Extracts: Comparison with Dust Extracts fro Cat-Containing Environment. J Allergy Clin Immunol 1987; 79:955-9.

22. Wood RA, Chapman MD, Adkinson NF, Egglsesto PA. The Effect of Cat Removal on Allergen Content in Household-Dust Samples. J Allergy Clin Immunol 1989; 83:730-4.

23. Korsgaard J. Mite Asthma and Residency: A Case-Control Study on the Impact of Exposure to House-Dust Mites in Dwellings. Am Rev Respir Dis 1983; 128: 231-235.

24. Hering SV Editor. Air Sampling Instruments. American Conference of Governmental Industrial Hygienists, Cincinnati, 1989, pp184-193, 214-217, 220.

25. Cunnington AM, Gregory PH. Mites in Bedroom Air. Nature 1968; 217:1271-1272.

26. Swanson MC, Campbell AR, Klauck MJ, Reed CE. Correlations between Levels of Mite and Cat Allergens in Settled and Airborne Dust. J Allergy Clin Immunol 1989; 83:776-83.

27. Swanson MC, Agarwal MK, Reed CE. An Immunochemical Approach to Indoor Aeroallergen Quantitation with a New Volumetric Air Sampler: Studies with Mite, Roach, Cat, Mouse, and Guinea Pig Antigens. J Allergy Clin Immunol 1985; 76:724-9.

28. Platts-Mills TAE, Heymann PW, Longbottom JL, Wilkins SR. Airborne Allergens Associated with Asthma: Particle Sizes Carrying Dust Mite and Rat Allergens Measured with a Cascade Impactor. J Allergy Clin Immunol 1986; 77: 850-7.

29. Chapman MD, Heymann PW, Wilkins SR, Brown MJ, Platts-Mills TAE. Monoclonal Immunoassays for Major Dust Mite (Dermatophagoides) Allergens, Der P I and Der F I, and Quantitative Analysis of the Allergen Content of Mite and House Dust Extracts. The Journal of allergy and Clinical Immunology 1987; 80(2):184-194.

30. Chapman MD, Heymann PW, Platts-Mills TAE. Epitope Mapping of Two Major Inhalant Allergens, Der P I and Der F I, from Mites of the Genus Dermatophagoides. The Journal of Immunology 1987; 139:1479-1484.

31. Chapman MD, Li Y. Epitope Mapping of the Major Felinne Salivary Allergen Fel-dI. J Allergy Clin Immunol 1988. 81:301 Abstract.

32. Chapman MD, Aalberse RC, Brown MJ, Platts-Mills TAE. Monoclonal Antibodies to the Major Feline Allergen Fel d I. II. Single Step Affinity Purification of Fel d I, N-Terminal Sequence Analysis, and Development of a Sensitive Two-Site Immunoassay to Assess Fel d I Exposure. The Journal of Immunology 1988; 140:812-818.

33. Chapman MD. Monoclonal Antibodies as Structural Probes for Mite, Cat and Cockroach Allergens. Adv in Biosci 1989. 74:281.

Other Sources not Cited

1. Lind P. Demonstration of Close Physichemical Similarity and Partial Immunochemical Identity between the Major Allergen, Dp42, of the House Dust Mite, D. Pteronyssinus and Corresponding Antigens of D. Farinae (Df6) and D. Microceras (Dm6). International Archives of Allergy and Applied Immunology 1986; 79:60-65.

2. Korsgaard J. Preventive Measures in House-Dust Allergy. Am Rev Respir Dis 1982; 125:80-84.

3. Chapman MD, Sutherland WM, Platts-Mills TAE. Recognition of Two Dermatophagoides pteronyssinus-Specific Epitopes on Antigen P I by Using Monoclonal Antibodies: Binding to Each Epitope Can Be Inhibited by Serum from Dust Mite-Allergic Patients. The Journal of Immunology 1984; 133(5):2488-2495.

4. Chapman MD, Luczynska CM, Platts-Mills TAE. Hidden Allergic Factors in the Etiology of Asthma. Chest 1988; 94:185-189.

5. Lind P, Norman PS, Newton MN, Lowenstein H, Schwartz B. The Prevalence of Indoor Allergens in the Baltimore Area: House Dust-Mite and Animal-Dander Antigens Measured by Immunochemical Techniques. The Journal of Allergy and Clinical Immunology 1987; 80:541-7.

6. Hamilton RG. House Dust Environmental Sampling and Mite/Cat Antigen Immunoassy Protocols (unpublished).

7. Sarsfield JK, Gowland G, Toy R, Norman ALE. Mite Sensitive Asthma of

Childhood: Trial of Avoidance Measures. Archives of Disease in Childhood 1974; 49:716-721.

8. Korsgaard J. Preventive Measures in Mite Asthma: A Controlled Trial. Allergy 1983; 38: 93-102.

9. Burr ML, St Leger AS, Neale E. Anti-Mite Measures in Mite-Sensitive Adult Asthma: A Controlled Trial. The Lancet 1976; ***:333-335.

10. Tuft L. Importance of Inhalant Allergens in Atopic Dermatitis. The Journal of Investigative Dermatology 1949; 12:211-219.

11. Schwartz B, Lind P, Lowenstein H. Level of Indoor Allergens in Dust from Homes of Allergic and Non-Allergic Individuals. Int Archs Allergy Appl Immun 1987; 82: 447-449.

12. Eggleston PA, Newill CA, Ansari AA, Pustelnik A, Lou S, Evans R, Marsh DG, Longbottom JL, Corn M. Task-Related Variation in Airborne Concentrations of Laboratory Animal Allergens: Studies with Rat nI. J Allergy Clin Immunol 1989; 84(3): 347-352.

13. Annals of the American Conference of Governmental Industrial Hygienists: ACGIH Transactions - 1984. American Conference of Governmental Industrial Hygienists, Cincinnati, 1984, pp 27-100.

APPENDIX 1

DESCRIPTION OF SAMPLE SITES

APPENDIX 1

DESCRIPTION OF SAMPLE SITES

The following sites were sampled.

1. HOUSE A. Gambrills, MD. This home is occupied by a family two adults and0852HGildren. The home is 18 years old and has had present occupants almost one year. Sites were selected within the home as follows:

a. Master Bedroom: futon and surrounding carpet. Futon rests directly on the floor. Surface sample numbers V001 and V013 were taken from futon pad and futon; number V002 was collected from the surrounding carpet.

b. Upstairs childrens' bedroom: Child's futon was selected because she sweats profusely at night, goes to bed with wet hair, and has wet the bed frequently for years. Sample #V003 was collected from both sides of the futon and the underlying mattress (her futon is on top of a twin bed); #V004 was from the surrounding carpet.

c. Lower floor livingroom: The sofa and carpet were sampled. #V005 was from the sofa seat and back cushions; #V006 was from the carpet.

d. Lower floor childrens' bedroom: The futon on the lower bunk bed was sampled because that child sweats profusely at night, wets about once a week, and goes to bed with wet hair. Sample #V007 was collected from both sides of the futon; #V008 was from the carpet in that room, which was brought from Guam (not wall-to-wall). This room is also shared by the laundry.

2. HOUSE B. Gambrills. MD. This home is occupied by two adults, one long-hair cat, and a poodle in the home. It is also about 18 years old. Sample #V009 was collected from the two velour easy chairs, which the cat and dog spend a lot of time on. Sample #V010 was collected from the carpet

in the same room. V033 was collected from the carpet in the dining room in front of the sliding glass door where the cat likes to sleep.

3. HOUSE C. Severn, MD. This home is occupied by a couple with 5 children. The mother has recently been diagnosed as having several allergies. The first floor family room sofa top surfaces were sampled #V011; and the carpet in front of the TV was sampled #V012.

4. HOUSE D. Gambrills, MD. This home is half of a duplex, and is occupied by a couple with three children. One child is asthmatic and has allergies. The asthmatic child's mattress was sampled #V014, and the carpet beside her bed was sampled #V015.

5. HOUSE E. Ft Meade, MD. This home is occupied by two adults, two teenagers and two dogs; and the home is used as a home day care center for up to 6 children (generally toddlers ages 1 to 4). Three areas were sampled in the livingroom, which is occupied most of each day: V016 was from the carpet, which is vacuumed twice a day; V017 was from a velour reclining chair; V018 was from an old chair used by the children for naps. One adult smokes, the other quit a couple of months ago.

6. HOUSE F. Laurel, MD. This home is occupied by two adults and two indoor-only cats who were shedding quite heavily at the time of sampling. Two samples were collected: V019 was collected from a velour chair that the cats sleep on frequently; V020 was collected from the carpet in front of this chair.

7. HOUSE G. Bolling AFB, DC. This home is occupied by two adults and three children. Four samples were collected. Sample V021 was from one of the livingroom sofas, and V022 was from the floor in front of it. Sample V023 was collected from a braided carpet in the boys' bedroom, and V024 was collected from three of their bed pillows.

8. HOUSE H. Columbia, MD. This is a three-story townhouse occupied by a

couple with two young children. Sample V025 was collected from the couch in the family room; V026, from the carpet in front of the TV; V027, from the feather pillow and down comforter in the master bedroom.

9. HOUSE I. Laurel, MD. This home is in an apartment building, and is occupied by a couple with older children. The wife sleeps on a feather pillow, and has symptoms indicating house dust allergy. Four of her siblings and a parent have asthma. Sample V038 was collected from the feather pillow; V039, from the mattress surface; and V040 from the carpet beside the bed in the master bedroom.

APPENDIX 2

VACUUM SAMPLE FORM

SAMPLING DATA COLLECTION FORM

VACUUM SURFACE SAMPLES

SAMPLE NUMBER:

DATE OF SAMPLE COLLECTION:

START TIME: FINISH TIME:

TOTAL SAMPLE TIME:

AREA SAMPLED (SQUARE INCHES OR SQUARE FEET):

SAMPLE LOCATION

ADDRESS:

ROOM AND FLOOR:

TYPE OF SURFACE:

SPECIAL FEATURES:

CONDITIONS AT TIME OF SAMPLE COLLECTION

WINDOWS OPEN?

AIR CONDITIONING ON?

LAST TIME PET WAS IN ROOM AND TYPE OF PET:

ANY SPECIAL TREATMENTS DONE TO REDUCE DUST OR OTHER ALLERGENS:

DOES ANYONE SMOKE IN THIS ROOM?

ARE FOODS STORED OR CONSUMED IN THIS ROOM (GIVE FREQUENCY):

APPENDIX 3

AIR SAMPLING FORM

AIR SAMPLE DATA COLLECTION FORM - AIRBORNE ALLERGEN STUDY
TOTAL DUST SAMPLE

SAMPLE NUMBER:

SAMPLE COLLECTION DATES:

START TIME/DATE: FINISH TIME/DATE:

TOTAL SAMPLE TIME:

PUMP USED: CRITICAL ORIFICE SN AND NOMINAL FLOW:

CRITICAL ORIFICE ACTUAL FLOW AND CALIBRATION DATA:

SAMPLE VOLUME:

SAMPLE LOCATION

ADDRESS:

ROOM AND FLOOR/S (SPECIFY TIME AT EACH IF MORE THAN ONE):

HEIGHT:

CONDITIONS AT TIME OF SAMPLING:

WINDOWS OPEN (GENERAL WEATHER CONDITIONS IF YES)?

AIR CONDITIONING ON (CENTRAL OR WINDOW)?

FAN ON?

LAST TIME PET WAS IN ROOM/S AND TYPE OF PET:

ANY SPECIAL TREATMENTS DONE TO REDUCE DUST OR OTHER ALLERGENS (AIR CLEANERS, ETC):

DOES ANYONE SMOKE IN THIS ROOM?

ARE FOODS STORED OR CONSUMED IN THIS ROOM:

NUMBER OF HOURS ROOM WAS OCCUPIED DURING SAMPLE PERIOD AND TYPE OF ACTIVITY DONE (E.G. 8 HRS OF SLEEPING BY 1 CHILD, WATCHED TV 2 HRS, VACUUMED, DUSTED, WRESTLED WITH DOG, ETC):

IS THERE A LARGE, MEDIUM, OR SMALL HORIZONTAL SURFACE AREA IN THIS ROOM? DESCRIBE.

IS THERE TEXTURED WALLPAPER?

DESCRIBE FLOORING (WALL-TO-WALL CARPET, DEEP PILE OR SHORT, BARE WOOD OR TILE FLOOR, THROW-RUG, ETC)

AVERAGE NUMBER OF OCCUPANTS IN HOME (INCLUDE FREQUENT OCCUPANTS SUCH AS CHILDREN WHO ARE PROVIDED HOME DAYCARE), BY AGE:

0-1:
1-3:
4-12:
12-17:
18-35:
36-55:
55+:

APPENDIX 4

LINEAR REFRESSION/ANCOVA

VACUUM SAMPLE TIME VS AREA

```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vac2.doc
[i] $subfile a:vac2.doc
[i] $units 41$
[i] !This is a data set of all vacuum samples which were collected then
[i] !determined to have sufficient mass to be analyzed by the DACT Lab.
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/surface. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328      767   97    8     115.1  3    3      1    1
[i] 2  0.245      1156  57    8     60     1    3      1    1
[i] 3  0.227      118   997   7     19     3    3      1    1
[i] 4  0.227      116   132   7     52.7   1    2      1    1
[i] 5  0.621      60    563   5     37.5   2    2      1    2
[i] 6  0.063      247   25    5     47     1    2      1    2
[i] 7  0.159      25    157   8     37.5   3    3      1    1
[i] 8  0.179      25    557   6     40     1    2      1    1
[i] 9  0.135   54  2323180     6     17.1   2    3      2    3
[i] 10  0.034  70    264397    10    33.8   1    1      2    3
[i] 11  0.696    318   3323    8.5   23.125  2   3      1    4
[i] 12  0.099    222     2281  7.5   14.6   1    3      1    4
[i] 13  0.247   1167    202    7     76.7    3    3      1    1
[i] 14   0.338  168    97    4.5    9.5    3    1      1    1
[i] 15  0.621   175    228    5     12.75  1    3      1    1
[i] 16  0.886   25     25     5     12     1   3       1    4
[i] 17   0.083  25    207    4     8.7     1    3      1    4
[i] 18  0.322   373    25     5     6.4    2   3       1    4
[i] 19  0.087  836  8777972  4     4.3    2    3      2    3
[i] 20  0.024  5718  1830677   5    9.9    1  2        2    3
[i] 21  0.068  301   613      5     13    2   3       1    4
[i] 22  1.302   513   229     7     19.4   1   3       1    4
[i] 23   0.393  208   124     7     12.8   1  3        1    3
[i] 24   0.020  205   25     4.5    20.25  3  1        1    3
[i] 25  0.219   20886  57   8     22.3    1   3       1    3
[i] 26  0.034   3183   25   4    11.9    1    2        1    3
[i] 27  0.038    201   25   4    26.2    3     3       1    1
[i] 28  0.949   62    1350  7.5  23.8    2   2         1    2
[i] 29   0.145   115   25   9    19.0  3   3           1    1
[i] 30  0.148    371    152  7    38.4   3   3         1    1
[i] 32  0.152  59   3134314  4    8.2    2   3         2    3
[i] 33  1.029  25  147843    4     6.0   1  2          2    3
[i] 34  0.372  25  114042      4.5   6.1  1  2         2    3
[i] 35  0.036  548   25      7     6.4   2  3          1    4
[i] 36  0.992   190   305   5    9.0    1  3           1    1
[i] 37  0.040   125   514   6    18.1   3   1          1    1
[i] 39  0.180   976   25    5     7.8    3   1         1    4
[i] 41  0.3138  1233  1051  9   11.3    2   3         1    4
[i] 42  0.2433   1657  461  8   11.7   1    3         1    4
[i] 44  0.4155  292   298   6   8.9   2    3          1    4
[i] 45  1.3827   454    25  6   10.3  1   3           1    4
```

```
[i]
[i] $finish$
[i] ? $tab the time mean$tab the time se$
[o]             6.171
[o]             4.000
[i] ? $tab the area mean$tab the area se$
[o]             23.13
[o]             4.300
[i] ? $plot time area$
[o]     9.900 |              T
[o]     9.600 |
[o]     9.300 |
[o]     9.000 |     T  T
[o]     8.700 |
[o]     8.400 |         T
[o]     8.100 |     T   T     T        T                       T
[o]     7.800 |
[o]     7.500 |      T   T
[o]     7.200 |
[o]     6.900 |   T T  2      T     T          T
[o]     6.600 |
[o]     6.300 |
[o]     6.000 |    2  2        T
[o]     5.700 |
[o]     5.400 |
[o]     5.100 |   223          T   T
[o]     4.800 |
[o]     4.500 |  T T   T
[o]     4.200 |
[o]     3.900 |  22 T    T
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]           0.0       25.0      50.0      75.0      100.0     125.0     150.0
[i] ? $yvar time$fac type 3$fac trap 3$fac cat 2$fac food 4$link i$error n$
[i] ? $fit %gm$dis e$fit +area$dis e$
[o] deviance = 110.30
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
[o]     1       6.171      0.2593     1
[o]     scale parameter taken as  2.758
[o]
[o] deviance = 94.152 (change =  -16.15)
[o]     d.f. = 39     (change =   -1   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       5.502      0.3547     1
[o]     2     0.02892     0.01118     AREA
[o]     scale parameter taken as  2.414
[o]
```

```
[i] ? $calc res=area-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [-15.,  0.) 1  S
[o] [  0., 15.) 30 SSSSSSSSSSSSSSSSSSSSSSSSSSSSS
```

```
[o] [ 15., 30.) 7  SSSSSSS
[o] [ 30., 45.) 2  SS
[o] [ 45., 60.) 0
[o] [ 60., 75.] 1  S
[i] ? !a bit skewed
[i] ?
[i] ? $fit -%gm$dis e$
[o] deviance = 674.97 (change =  +580.8)
[o]     d.f. =  40    (change =    +1  )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.1554     0.02023     AREA
[o]     scale parameter taken as  16.87
[o]
[i] ? !That subtracted the grand mean and forced the line through the origin
[i] ? !no time for no area.
[i] ? $fit +trap$dis e$fit +type$dis e$fit +cat$dis e$
[o] deviance = 83.834 (change =  -591.1)
[o]     d.f. = 37     (change =    -3  )
[o]
[o]          estimate        s.e.     parameter
[o]     1     0.03020     0.01089     AREA
[o]     2       5.460      0.7008     TRAP(1)
[o]     3       4.545      0.5767     TRAP(2)
[o]     4       5.783      0.3839     TRAP(3)
[o]     scale parameter taken as  2.266
[o]
[o] deviance = 80.404 (change =  -3.430)
[o]     d.f. = 35     (change =  -2    )
[o]
[o]          estimate        s.e.     parameter
[o]     1     0.03695     0.01243     AREA
[o]     2       6.029      0.8596     TRAP(1)
[o]     3       4.378      0.6234     TRAP(2)
[o]     4       5.865      0.4819     TRAP(3)
[o]     5    -0.04090      0.5927     TYPE(2)
[o]     6     -0.8624      0.7218     TYPE(3)
[o]     scale parameter taken as  2.297
[o]
[o] deviance = 79.332 (change =  -1.072)
[o]     d.f. = 34     (change =  -1    )
[o]
[o]          estimate        s.e.     parameter
[o]     1     0.03584     0.01263     AREA
[o]     2       6.205      0.9042     TRAP(1)
[o]     3       4.553      0.6793     TRAP(2)
[o]     4       5.948      0.5009     TRAP(3)
[o]     5    0.003016      0.6008     TYPE(2)
[o]     6     -0.9402      0.7364     TYPE(3)
[o]     7     -0.4682      0.6908     CAT(2)
[o]     scale parameter taken as  2.333
[o]
[i] ? !trapping and presence of a cat are significant in the length of time
[i] ? !it took to vacuum a given area
[i] ? $tab the time mean for trap;cat;type$
[w] -- the table contains empty cell(s)
[o]          1                          2
[o]          1       2       3          1       2       3
```

```
[o]      1    0.000    0.000    5.000    10.000    0.000    0.000
[o]      2    5.500    6.250    0.000     4.500    0.000    0.000
[o]      3    6.409    6.750    7.143     0.000    4.667    0.000
[i] ? $stop$
```

APPENDIX 5

HISTOGRAMS OF DER F 1 and FEL D 1 VACUUM SAMPLE RESULTS

```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vac2.doc
[i] $subfile a:vac2.doc
[i] $units 41$
[i] !This is a data set of all vacuum samples which were collected then
[i] !determined to have sufficient mass to be analyzed by the DACI Lab.
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/surface. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328       767   97    8      115.1  3    3       1    1
[i] 2  0.245       1156  57    8     60      1    3        1  1
[i] 3  0.227       118   997   7     19     3     3       1    1
[i] 4  0.227       116   132   7     52.7   1     2       1    1
[i] 5  0.621       60   563    5    37.5    2     2       1    2
[i] 6  0.063       247   25    5     47     1     2       1    2
[i] 7  0.159       25    157   8     37.5   3     3       1    1
[i] 8  0.179      25     557   6     40     1     2       1    1
[i] 9  0.135    54  2323180     6    17.1    2     3       2    3
[i] 10  0.034  70    264397     10   33.8    1    1        2    3
[i] 11  0.696    318   3323    8.5  23.125   2   3         1   4
[i] 12  0.099    222     2281  7.5  14.6    1    3         1   4
[i] 13  0.247   1167    202    7    76.7     3    3        1   1
[i] 14   0.338  168    97    4.5    9.5     3     1       1   1
[i] 15  0.621   175    228    5     12.75   1    3        1   1
[i] 16  0.886   25    25     5     12      1   3          1   4
[i] 17   0.083  25   207     4     8.7      1    3        1   4
[i] 18  0.322   373   25       5   6.4     2   3          1   4
[i] 19  0.087  836  8777972  4     4.3     2    3         2   3
[i] 20  0.024  5718  1830677   5    9.9    1  2           2   3
[i] 21  0.068  301   613       5    13    2   3           1   4
[i] 22  1.302   513   229     7     19.4   1   3          1   4
[i] 23   0.393  208   124     7      12.8   1  3          1   3
[i] 24   0.020  205   25      4.5    20.25  3  1          1   3
[i] 25  0.219   20886  57   8     22.3    1   3          1   3
[i] 26  0.034   3183   25   4    11.9   1    2           1   3
[i] 27  0.038    201   25   4    26.2   3     3          1   1
[i] 28  0.949   62    1350  7.5  23.8   2   2            1   2
[i] 29   0.145   115   25   9    19.0  3   3             1   1
[i] 30  0.148    371    152  7    38.4   3   3           1   1
[i] 32  0.152  59   3134314  4    8.2    2   3           2   3
[i] 33  1.029  25  147843    4     6.0   1  2            2   3
[i] 34  0.372  25  114042      4.5   6.1  1  2           2   3
[i] 35  0.036  548   25      7     6.4   2  3            1   4
[i] 36  0.992   190   305   5    9.0    1  3             1   1
[i] 37  0.040   125   514   6    18.1   3   1            1   1
[i] 39  0.180   976   25    5     7.8    3   1           1   4
[i] 41  0.3138  1233  1051  9   11.3    2   3           1   4
[i] 42  0.2433   1657  461  8   11.7   1    3           1   4
[i] 44  0.4155  292   298   6   8.9   2    3            1   4
[i] 45  1.3827   454    25  6   10.3  1   3             1   4
```

```
[i]
[i] $finish$
[i] ? $hist cngg$tab the cngg mean$tab the cngg se$
[o] [       0.,1500000.) 37 CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
[o] [1500000.,3000000.) 2  CC
[o] [3000000.,4500000.) 1  C
[o] [4500000.,6000000.) 0
[o] [6000000.,7500000.) 0
[o] [7500000.,9000000.] 1  C
[o]             405042.
[o]               25.00
[i] ? !This is the histogram of Fel d 1 antigen in ng/g with mean and se
[i] ? $calc lc=%log cngg$hist lc$
[o] [ 2.5, 5.0) 16 LLLLLLLLLLLLLLLL
[o] [ 5.0, 7.5) 16 LLLLLLLLLLLLLLLL
[o] [ 7.5,10.0) 2  LL
[o] [10.0,12.5) 3  LLL
[o] [12.5,15.0) 3  LLL
[o] [15.0,17.5] 1  L
```

```
[i] ? $tab the lc mean$tab the lc se$
[o]               6.501
[o]               3.219
[i] ? !This is the histogram of the ln of Fel d 1 in ng/g with mean and se.
[i] ? !Bimodal due to whether or not there is a cat present.
[i] ? $calc ctot=cngg*dtot$hist ctot$tab the ctot mean for cat$
[o] [     0.,150000.) 37 CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
[o] [150000.,300000.) 1  C
[o] [300000.,450000.) 1  C
[o] [450000.,600000.) 1  C
[o] [600000.,750000.) 0
[o] [750000.,900000.] 1  C
[o]             1.000    2.000
[o]    []        183.  257316.
[i] ? $tab the ctot se for cat$
[o]           1.000  2.000
[o]    []        1.  8989.
```

```
[i] ? $calc lctot=%log ctot$hist lctot$tab the lctot mean for cat$
[o] [ -1.0,  1.5) 6  LLLLLL
[o] [  1.5,  4.0) 16 LLLLLLLLLLLLLLLL
[o] [  4.0,  6.5) 10 LLLLLLLLLL
[o] [  6.5,  9.0) 2  LL
```

```
[o] [  9.0, 11.5) 3  LLL
[o] [ 11.5, 14.0] 4  LLLL
[o]         1.000  2.000
[o]    []   3.47  11.67
[i] ? $tab the lctot se for cat$
[o]         1.000  2.000
[o]    [] -0.693  9.104
[i] ? !This is the histogram of ln of total Fel d 1 on the sample filter
[i] ? !with means 1=no cat, 2=cat present.
[i] ? $calc csf=ctot/area$



[i] ? $hist csf$tab the csf mean for cat$tab the csf se for cat$
[o] [     0., 30000.) 39 CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
[o] [ 30000., 60000.) 1  C
[o] [ 60000., 90000.) 0
[o] [ 90000.,120000.) 0
[o] [120000.,150000.) 0
[o] [150000.,180000.] 1  C
[o]          1.000   2.000
[o]    []     10.  41579.
[o]         1.000  2.000
[o]    []    0.0  266.0
[i] ? !This is a histogram of Fel d 1 in ng/sf with means and se w/ and w/ou
[i] ?
[i] ? $calc lcsf=%log csf$hist lcsf$tab the lcsf mean for cat$
[o] [ -4.5, -1.5) 6  LLLLLL
[o] [ -1.5,  1.5) 17 LLLLLLLLLLLLLLLLL
[o] [  1.5,  4.5) 10 LLLLLLLLLL
[o] [  4.5,  7.5) 2  LL
[o] [  7.5, 10.5) 4  LLLL
[o] [ 10.5, 13.5] 2  LL
[o]         1.000  2.000
[o]    []  0.529  9.406



[i] ? $tab the lcsf se for cat$
[o]         1.000  2.000
[o]    [] -3.701  5.583
[i] ? !This is the histogram of the ln of Fel d 1 in ng/sf with means and se
[i] ? $calc ta=time*area$calc cta=ctot/ta$hist cta$
[o] [    0., 8000.) 39 CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
[o] [ 8000.,16000.) 1  C
[o] [16000.,24000.) 0
[o] [24000.,32000.) 0
[o] [32000.,40000.) 0
[o] [40000.,48000.] 1  C
```

```
[i] ? $tab the cta mean for cat$tab the cta se for cat$
[o]          1.000   2.000
[o]    []      1.  10111.
[o]         1.000  2.000
[o]    []    0.01  26.60
[i] ? $calc lcta=%log cta$hist lcta$tab the lcta mean for cat$
[o] [ -6.0, -3.0) 8  LLLLLLLL
[o] [ -3.0,  0.0) 15 LLLLLLLLLLLLLLL
[o] [  0.0,  3.0) 11 LLLLLLLLLLL
[o] [  3.0,  6.0) 1  L
[o] [  6.0,  9.0) 4  LLLL
[o] [  9.0, 12.0] 2  LL
[o]         1.000  2.000
[o]    [] -1.288  7.782
```

```
[i] ? $tab the lcta se for cat$
[o]         1.000  2.000
[o]    [] -5.205  3.281
[i] ? !This is a histogram of the ln of Fel d 1 in ng/sf*min with mean and s
[i] ?
```

```
[i]
[i] $finish$
[i] ? $tab the mngg mean$tab the mngg se$
[o]              1056.
[o]              25.00
[i] ? $stop$
```

```
[i]
[i] $finish$
[i] ? $hist mngg$
[o] [    0., 4000.) 39 MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
[o] [ 4000., 8000.) 1  M
[o] [ 8000.,12000.) 0
[o] [12000.,16000.) 0
[o] [16000.,20000.) 0
[o] [20000.,24000.] 1  M
[i] ? !This is a histogram of Der f 1 in ng/g
```

```
[i] ? $calc lm=%log mngg$hist lm$
[o] [ 3.0, 4.2) 10 LLLLLLLLLL
[o] [ 4.2, 5.4) 11 LLLLLLLLLLL
[o] [ 5.4, 6.6) 10 LLLLLLLLLL
[o] [ 6.6, 7.8) 7  LLLLLLL
[o] [ 7.8, 9.0) 2  LL
[o] [ 9.0,10.2] 1  L
[i] ? !This is a histrogram of the ln of Der f 1 in ng/g
[i] ? $tab the lm mean$tab the lm se$
[o]              5.477
[o]              3.219
[i] ? !5.477 is the mean of the ln of Der f 1 in ng/g.  3.219 is the s.e.
[i] ? $calc mtot=mngg*dtot$hist mtot$
[o] [   0., 800.) 40 MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
[o] [ 800.,1600.) 0
[o] [1600.,2400.) 0
[o] [2400.,3200.) 0
[o] [3200.,4000.) 0
[o] [4000.,4800.] 1  M
[i] ? !This is the histogram of Der f 1 antigen in ng/sample filter
[i] ? $Tab the mtot mean$tab the mtot se$
[o]              226.3
[o]              2.075
[i] ? $calc lmtot=%log mtot$hist lmtot$
[o] [0.0,1.5) 5  LLLLL
[o] [1.5,3.0) 8  LLLLLLLL
[o] [3.0,4.5) 12 LLLLLLLLLLL
[o] [4.5,6.0) 13 LLLLLLLLLLLL
[o] [6.0,7.5) 2  LL
[o] [7.5,9.0] 1  L
[i] ? !This is a histogram of the ln of the total Der f 1 per filter
[i] ? $Tab the lmtot mean$tab the lmtot se$
[o]              3.848
[o]             0.7300
[i] ? $calc msf= mtot/area$hist msf$
[o] [  0., 40.) 39 MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
[o] [ 40., 80.) 1  M
[o] [ 80.,120.) 0
[o] [120.,160.) 0
[o] [160.,200.) 0
[o] [200.,240.] 1  M
```

```
[i] ? !This is a histogram of Der f 1 in ng/sf
[i] ? $Tab the msf mean$tab the msf se$
[o]              13.43
[o]            0.07041
[i] ? $calc lmsf=%log msf$hist lmsf$tab the lmsf mean$tab the lmsf se$
[o] [-3.0,-1.5) 4  LLLL
[o] [-1.5, 0.0) 8  LLLLLLLL
[o] [ 0.0, 1.5) 12 LLLLLLLLLLLL
[o] [ 1.5, 3.0) 10 LLLLLLLLLL
[o] [ 3.0, 4.5) 6  LLLLLL
[o] [ 4.5, 6.0] 1  L
[o]              1.021
[o]             -2.653
[i] ? !This is a histogram of the ln of Der f 1 in ng/sf, with mean and se
[i] ? $calc ta=time*area$calc mta=mtot/ta$hist mta$tab the mta mean$
[o] [ 0.0, 5.0) 39 MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
[o] [ 5.0,10.0) 0
[o] [10.0,15.0) 1  M
[o] [15.0,20.0) 0
[o] [20.0,25.0) 0
[o] [25.0,30.0] 1  M
[o]              2.044
[i] ? $tab the mta se$
[o]            0.007041
```

```
[i] ? $calc lmta=%log mta$hist lmta$tab the lmta mean$tab the lmta se$
[o] [-5.00,-3.50) 3  LLL
[o] [-3.50,-2.00) 8  LLLLLLLL
[o] [-2.00,-0.50) 13 LLLLLLLLLLLLL
[o] [-0.50, 1.00) 7  LLLLLLL
[o] [ 1.00, 2.50) 9  LLLLLLLLL
[o] [ 2.50, 4.00] 1  L
[o]              -0.7634
[o]               -4.956
[i] ? !This is a histogram of the ln of Der f 1  in ng/sf*min with mean and
[i] ?
[i] ?
[i] ?
[i] ? $yvar msf$fac food 4$fac cat 2$fac type 3$fac trap 3$error n$link i$
[i] ? $fit %gm$dis e$
[o] deviance = 44313.
[o]     d.f. =    40
[o]
[o]           estimate        s.e.     parameter
[o]     1        13.43       5.198     1
[o]     scale parameter taken as  1108.
[o]
[i] ? $fit +type$dis e$
[o] deviance = 41812. (change =  -2501.)
[o]     d.f. =    38  (change =     -2 )
[o]
[o]           estimate        s.e.     parameter
[o]     1        21.52       7.610     1
```

```
[o]      2       -12.18        12.57     TYPE(2)
[o]      3       -17.97        12.57     TYPE(3)
[o]      scale parameter taken as  1100.
[o]
[i] ? $tab the msf mean for type$
[o]             1       2       3
[o]    []  21.520   9.342   3.549
```

APPENDIX 6

LINEAR REGRESSION/ANCOVA

TOTAL DER F 1 VS TOTAL SIEVED DUST

```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vac2.doc
[i] $subfile a:vac2.doc
[i] $units 41$
[i] !This is a data set of all vacuum samples which were collected then
[i] !determined to have sufficient mass to be analyzed by the DACI Lab.
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/surface. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328       767   97    8      115.1  3    3       1    1
[i] 2  0.245       1156  57    8      60      1    3        1  1
[i] 3  0.227       118   997   7      19     3     3       1    1
[i] 4  0.227       116   132   7      52.7   1     2       1    1
[i] 5  0.621       60   563    5     37.5    2     2       1    2
[i] 6  0.063       247   25    5      47     1     2       1    2
[i] 7  0.159       25    157   8      37.5   3     3       1    1
[i] 8  0.179      25     557   6      40     1     2       1    1
[i] 9  0.135    54  2323180     6     17.1    2     3       2    3
[i] 10  0.034  70    264397     10    33.8    1    1        2    3
[i] 11  0.696    318   3323     8.5  23.125   2    3        1    4
[i] 12  0.099    222     2281   7.5  14.6    1    3        1    4
[i] 13  0.247   1167    202     7     76.7     3    3       1    1
[i] 14   0.338  168    97    4.5     9.5     3     1       1    1
[i] 15  0.621   175    228    5      12.75   1    3        1    1
[i] 16  0.886   25    25      5     12      1   3          1    4
[i] 17   0.083  25   207      4     8.7      1    3        1    4
[i] 18  0.322   373   25        5   6.4     2   3          1    4
[i] 19  0.087  836  8777972  4     4.3     2    3         2    3
[i] 20  0.024  5718  1830677   5    9.9     1  2           2    3
[i] 21  0.068  301   613       5    13    2   3           1    4
[i] 22  1.302   513   229     7     19.4   1   3          1    4
[i] 23   0.393  208   124     7      12.8   1  3          1    3
[i] 24   0.020  205   25      4.5    20.25  3  1          1    3
[i] 25  0.219   20886  57   8     22.3    1   3          1    3
[i] 26  0.034   3183   25   4    11.9   1    2           1    3
[i] 27  0.038    201   25   4    26.2   3     3          1    1
[i] 28  0.949   62    1350  7.5  23.8   2   2            1    2
[i] 29   0.145   115   25   9    19.0  3   3             1    1
[i] 30  0.148    371    152  7    38.4   3   3           1    1
[i] 32  0.152  59   3134314  4    8.2    2   3           2    3
[i] 33  1.029  25  147843    4     6.0   1  2            2    3
[i] 34  0.372  25  114042      4.5   6.1  1  2           2    3
[i] 35  0.036  548   25      7     6.4   2  3            1    4
[i] 36  0.992   190   305   5    9.0    1  3             1    1
[i] 37  0.040   125   514   6    18.1   3   1            1    1
[i] 39  0.180   976   25    5     7.8    3   1           1    4
[i] 41  0.3138  1233  1051  9   11.3    2   3           1    4
[i] 42  0.2433   1657  461  8   11.7   1    3           1    4
[i] 44  0.4155  292   298   6   8.9   2    3            1    4
[i] 45  1.3827   454    25  6   10.3  1   3             1    4
```

```
[i]
[i] $finish$
[i] ? $calc mtot=mngg*dtot$calc lmt=%log mtot$calc ldtot=%log dtot$
[i] ? $plot mtot dtot$
[o]     5000. |
[o]     4750. |
[o]     4500. |       M
[o]     4250. |
[o]     4000. |
[o]     3750. |
[o]     3500. |
[o]     3250. |
[o]     3000. |
[o]     2750. |
[o]     2500. |
[o]     2250. |
[o]     2000. |
[o]     1750. |
[o]     1500. |
[o]     1250. |
[o]     1000. |
[o]      750. |                                          M  M
[o]      500. |         M M
[o]      250. |M     M 2  M            M          M
[o]        0. |623 5M 2  2MMM       2         M M M
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         0.000     0.300     0.600     0.900     1.200     1.500     1.800
```

```
[i] ? $plot lmt ldtot$
[o]     8.400 |                          L
[o]     8.000 |
[o]     7.600 |
[o]     7.200 |
[o]     6.800 |
[o]     6.400 |                                          2
[o]     6.000 |                          L L
[o]     5.600 |                          2  L
[o]     5.200 |                       L              L   L
[o]     4.800 |   L  L                          L L   L
[o]     4.400 |                 L                  L
[o]     4.000 |                       L        L         L
[o]     3.600 |                                       L
[o]     3.200 |               L   L        2              LL
[o]     2.800 |         L     L          L
[o]     2.400 |                                  L
[o]     2.000 |         L               LL
[o]     1.600 |L         L                 L
[o]     1.200 |                         L
[o]     0.800 |       L         L
[o]     0.400 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]        -4.00     -3.00     -2.00     -1.00      0.00      1.00      2.00
[i] ? $yvar lmt$fac type 3$fac trap 3$fac cat 2$fac food 4$error n$link i$
```

```
[i] ? $fit %gm$dis e$fit +ldtot$dis e$
[o] deviance = 123.45
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
[o]     1       3.848      0.2744     1
[o]     scale parameter taken as  3.086
[o]
[o] deviance = 94.173 (change =  -29.27)
[o]     d.f. = 39     (change =   -1   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       5.058      0.4239     1
[o]     2      0.7428      0.2133     LDTO
[o]     scale parameter taken as  2.415
[o]
[i] ? !R = 0.49, p<0.05
[i] ? $calc res=lmt-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [-1.60,-0.80) 9  SSSSSSSSS
[o] [-0.80, 0.00) 13 SSSSSSSSSSSSS
[o] [ 0.00, 0.80) 9  SSSSSSSSS
[o] [ 0.80, 1.60) 8  SSSSSSSS
[o] [ 1.60, 2.40) 1  S
[o] [ 2.40, 3.20] 1  S
[i] ? $plot %fv ldtot$
[o]     5.280 |                                                  2
[o]     5.120 |                                                2
[o]     4.960 |                                              2
[o]     4.800 |                                            %
[o]     4.640 |                                          2
[o]     4.480 |                                        %
[o]     4.320 |                                      %%%
[o]     4.160 |                                    %2
[o]     4.000 |                                33
[o]     3.840 |                              2
[o]     3.680 |                            3%
[o]     3.520 |                          %
[o]     3.360 |                        %
[o]     3.200 |                      %%
[o]     3.040 |                  %%
[o]     2.880 |
[o]     2.720 |            %
[o]     2.560 |          22
[o]     2.400 |
[o]     2.240 |   %
[o]     2.080 |%
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         -4.00     -3.00     -2.00     -1.00      0.00      1.00      2.00
[i] ? $fit +trap$dis e$fit +type$dis e$fit +cat$dis e$fit +food$dis e$
[o] deviance = 88.992 (change =  -5.181)
[o]     d.f. = 37     (change =  -2    )
[o]
[o]          estimate        s.e.     parameter
[o]     1       4.392      0.9196     1
[o]     2      0.6658      0.2268     LDTO
[o]     3     0.05162      0.8968     TRAP(2)
[o]     4      0.8047      0.8043     TRAP(3)
[o]     scale parameter taken as  2.405
```

```
[o]
[o] deviance = 87.640 (change =  -1.352)
[o]     d.f. = 35     (change =  -2    )
[o]
[o]           estimate        s.e.     parameter
[o]      1       4.686       1.049     1
[o]      2      0.6441      0.2337     LDTO
[o]      3     -0.2000       1.039     TRAP(2)
[o]      4      0.7102      0.8840     TRAP(3)
[o]      5     -0.3520      0.6149     TYPE(2)
[o]      6     -0.4406      0.6965     TYPE(3)
[o]     scale parameter taken as  2.504
[o]
[o] deviance = 83.819 (change =  -3.820)
[o]     d.f. = 34     (change =  -1    )
[o]
[o]           estimate        s.e.     parameter
[o]      1       4.887       1.054     1
[o]      2      0.5854      0.2367     LDTO
[o]      3     -0.2170       1.031     TRAP(2)
[o]      4      0.5529      0.8862     TRAP(3)
[o]      5     -0.2645      0.6142     TYPE(2)
[o]      6     -0.6632      0.7139     TYPE(3)
[o]      7     -0.8944      0.7185     CAT(2)
[o]     scale parameter taken as  2.465
[o]
[o] deviance = 74.631 (change =  -9.189)
[o]     d.f. = 31     (change =  -3    )
[o]
[o]           estimate        s.e.     parameter
[o]      1       4.170       1.290     1
[o]      2      0.7216      0.2446     LDTO
[o]      3      0.3633       1.169     TRAP(2)
[o]      4      0.8052      0.9208     TRAP(3)
[o]      5    -0.04226      0.7100     TYPE(2)
[o]      6    -0.03710      0.8785     TYPE(3)
[o]      7      -2.185       1.044     CAT(2)
[o]      8     -0.2340       1.385     FOOD(2)
[o]      9       1.836      0.9912     FOOD(3)
[o]     10      0.5128      0.8162     FOOD(4)
[o]     scale parameter taken as  2.407
[o]
[i] ? $stop$
```

APPENDIX 7

LINEAR REGRESSION/ANCOVA

TOTAL FEL D 1 VS TOTAL SIEVED DUST

```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vac2.doc
[i] $subfile a:vac2.doc
[i] $units 41$
[i] !This is a data set of all vacuum samples which were collected then
[i] !determined to have sufficient mass to be analyzed by the DACI Lab.
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/surface. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328       767   97    8      115.1  3    3       1    1
[i] 2  0.245       1156  57    8     60      1    3        1  1
[i] 3  0.227       118   997   7     19     3     3       1    1
[i] 4  0.227       116   132   7     52.7   1     2       1    1
[i] 5  0.621       60   563    5    37.5    2     2       1    2
[i] 6  0.063       247   25    5     47      1     2       1    2
[i] 7  0.159       25    157   8     37.5    3     3       1    1
[i] 8  0.179      25     557   6     40      1     2       1    1
[i] 9  0.135   54  2323180     6     17.1    2     3       2    3
[i] 10  0.034  70    264397     10   33.8    1    1        2    3
[i] 11  0.696    318   3323     8.5  23.125   2   3         1   4
[i] 12  0.099    222     2281  7.5  14.6    1    3         1   4
[i] 13  0.247   1167    202    7    76.7     3    3        1   1
[i] 14   0.338  168    97    4.5    9.5     3     1       1   1
[i] 15  0.621   175    228    5     12.75   1    3        1   1
[i] 16  0.886   25    25     5     12      1   3          1   4
[i] 17   0.083  25   207     4     8.7      1    3        1   4
[i] 18  0.322   373   25       5   6.4     2   3          1   4
[i] 19  0.087  836  8777972  4     4.3     2    3         2   3
[i] 20  0.024  5718  1830677   5    9.9    1  2           2   3
[i] 21  0.068  301   613       5    13    2   3           1   4
[i] 22  1.302   513   229     7     19.4   1   3          1   4
[i] 23   0.393  208   124     7      12.8   1  3          1   3
[i] 24   0.020  205   25      4.5    20.25  3  1          1   3
[i] 25  0.219   20886  57   8     22.3    1   3          1   3
[i] 26  0.034   3183   25   4    11.9   1    2           1   3
[i] 27  0.038    201   25   4    26.2   3     3          1   1
[i] 28  0.949   62    1350  7.5  23.8   2   2            1   2
[i] 29   0.145   115   25   9    19.0  3   3             1   1
[i] 30  0.148    371    152  7    38.4   3   3           1   1
[i] 32  0.152  59   3134314  4    8.2    2   3           2   3
[i] 33  1.029  25  147843    4     6.0   1  2            2   3
[i] 34  0.372  25  114042      4.5   6.1  1  2           2   3
[i] 35  0.036  548   25      7     6.4   2  3            1   4
[i] 36  0.992   190   305   5    9.0    1  3             1   1
[i] 37  0.040   125   514   6    18.1   3   1            1   1
[i] 39  0.180   976   25    5     7.8    3   1           1   4
[i] 41  0.3138  1233  1051  9   11.3    2   3           1   4
[i] 42  0.2433   1657  461  8   11.7   1    3           1   4
[i] 44  0.4155  292   298   6   8.9   2    3            1   4
[i] 45  1.3827   454    25  6   10.3  1   3             1   4
```

```
[i]
[i] $finish$
[i] ? $calc ctot=cngg*dtot$calc lct=%log ctot$calc ldt=%log dtot$
[i] ? $plot ctot dtot$
[o]   800000. |
[o]   760000. |  C
[o]   720000. |
[o]   680000. |
[o]   640000. |
[o]   600000. |
[o]   560000. |
[o]   520000. |
[o]   480000. |    C
[o]   440000. |
[o]   400000. |
[o]   360000. |
[o]   320000. |    C
[o]   280000. |
[o]   240000. |
[o]   200000. |
[o]   160000. |                                  C
[o]   120000. |
[o]    80000. |
[o]    40000. |C          C
[o]        0. |622 32C5 C3 CC      2 C      C CC         C  C
[o] ----------:--------:--------:--------:--------:--------:---------:
[o]         0.000     0.300     0.600     0.900     1.200     1.500     1.800
[i] ? $plot lct ldt$
[o]    14.400 |
[o]    13.600 |               L
[o]    12.800 |                  LL
[o]    12.000 |                                     L
[o]    11.200 |
[o]    10.400 |  L                          L
[o]     9.600 |
[o]     8.800 |     L
[o]     8.000 |                                  L
[o]     7.200 |                                     L
[o]     6.400 |
[o]     5.600 |                 L       L  L      L    L  L
[o]     4.800 |                       L  L    L   L
[o]     4.000 |             L            L    L
[o]     3.200 |       L      L     LL  L   2         L   L
[o]     2.400 |                        LL  L
[o]     1.600 |                     L L
[o]     0.800 |           L
[o]     0.000 |     L2
[o]    -0.800 |L
[o]    -1.600 |
[o] ----------:--------:--------:--------:--------:--------:---------:
[o]        -4.00     -3.00     -2.00     -1.00      0.00      1.00      2.00
[i] ? $yvar lct$fac type 3$fac trap 3$fac cat 2$fac food 4$error n$link i$
[i] ? $fit %gm$dis e$fit +ldt$dis e$
[o] deviance = 550.42
[o]     d.f. =  40
[o]
[o]           estimate        s.e.     parameter
[o]     1        4.872      0.5793     1
```

```
[o]     scale parameter taken as  13.76
[o]
[o] deviance = 525.49 (change =  -24.93)
[o]     d.f. =  39    (change =   -1   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       5.989       1.001     1
[o]     2      0.6854      0.5039     LDT
[o]     scale parameter taken as  13.47
[o]
[i] ? !Slope is not significant -overlaps zero
[i] ? $calc res=lct-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [-1.60,-0.80) 8  SSSSSSSS
[o] [-0.80, 0.00) 20 SSSSSSSSSSSSSSSSSSSS
[o] [ 0.00, 0.80) 6  SSSSSS
[o] [ 0.80, 1.60) 2  SS
[o] [ 1.60, 2.40) 4  SSSS
[o] [ 2.40, 3.20] 1  S
[i] ? $plot %fv ldt$
[o]     6.400 |
[o]     6.240 |                                                  2
[o]     6.080 |                                                %
[o]     5.920 |                                               2%
[o]     5.760 |                                             %
[o]     5.600 |                                           2
[o]     5.440 |                                         %
[o]     5.280 |                                       3%%
[o]     5.120 |                                     %
[o]     4.960 |                                  33
[o]     4.800 |                               %2
[o]     4.640 |                            %3
[o]     4.480 |                         %
[o]     4.320 |                      %%
[o]     4.160 |                  %%
[o]     4.000 |
[o]     3.840 |            %
[o]     3.680 |         22
[o]     3.520 |
[o]     3.360 |% %
[o]     3.200 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]          -4.00     -3.00     -2.00     -1.00      0.00      1.00      2.00
[i] ? $fit +trap$dis e$fit +type$dis e$fit +cat$dis e$fit +food$dis e$
[o] deviance = 507.26 (change =  -18.23)
[o]     d.f. =  37    (change =   -2   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       4.913       2.195     1
[o]     2      0.6112      0.5414     LDT
[o]     3       2.141       2.141     TRAP(2)
[o]     4      0.7362       1.920     TRAP(3)
[o]     scale parameter taken as  13.71
[o]
[o] deviance = 423.49 (change =  -83.78)
[o]     d.f. =  35    (change =   -2   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       6.367       2.307     1
```

```
[o]      2       0.5239       0.5138      LDT
[o]      3      0.06038        2.284      TRAP(2)
[o]      4       -1.025        1.943      TRAP(3)
[o]      5        2.184        1.352      TYPE(2)
[o]      6       -2.109        1.531      TYPE(3)
[o]      scale parameter taken as  12.10
[o]
[o] deviance = 71.922 (change =  -351.6)
[o]      d.f. = 34     (change =    -1  )
[o]
[o]           estimate         s.e.      parameter
[o]      1       4.443       0.9760      1
[o]      2       1.087       0.2192      LDT
[o]      3      0.2235       0.9553      TRAP(2)
[o]      4      0.4842       0.8209      TRAP(3)
[o]      5       1.344       0.5689      TYPE(2)
[o]      6     0.02706       0.6613      TYPE(3)
[o]      7       8.580       0.6656      CAT(2)
[o]      scale parameter taken as  2.115
[o]
[o] deviance = 65.832 (change =  -6.090)
[o]      d.f. = 31     (change =  -3    )
[o]
[o]           estimate         s.e.      parameter
[o]      1       5.483        1.212      1
[o]      2       1.005       0.2298      LDT
[o]      3     -0.3770        1.098      TRAP(2)
[o]      4      0.1274       0.8648      TRAP(3)
[o]      5       1.422       0.6668      TYPE(2)
[o]      6     -0.7398       0.8251      TYPE(3)
[o]      7       9.178       0.9804      CAT(2)
[o]      8     -0.4621        1.301      FOOD(2)
[o]      9      -1.431       0.9309      FOOD(3)
[o]     10     -0.9702       0.7666      FOOD(4)
[o]      scale parameter taken as  2.124
[o]
[i] ? !When presence of a cat is accounted for, the slope becomes significan
[i] ? $stop$
```

APPENDIX 8

ANOVAS FOR DER F 1

```
[i] ? $yvar lmsf$fac type 3$error n$link i$fit %gm$dis e$
[w] -- model changed
[o] deviance = 147.78
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.021      0.3002     1
[o]     scale parameter taken as  3.694
[o]
```

```
[i] ? $fit +type$dis e$tab the lmsf mean for type$
[o] deviance = 135.19 (change =  -12.59)
[o]     d.f. =  38    (change =   -2   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.303      0.4327     1
[o]     2      0.1403      0.7146     TYPE(2)
[o]     3      -1.193      0.7146     TYPE(3)
[o]     scale parameter taken as  3.558
[o]
[o]          1       2       3
[o]    []  1.3033  1.4436  0.1108
[i] ? $yvar mta$error n$link i$fac type 3$fit %gm$dis e$fit +type$dis e$
[w] -- model changed
[o] deviance = 743.85
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
[o]     1       2.044      0.6735     1
[o]     scale parameter taken as  18.60
[o]
[o] deviance = 697.19 (change =  -46.66)
[o]     d.f. =  38    (change =   -2   )
[o]
[o]          estimate        s.e.     parameter
[o]     1       3.140      0.9827     1
[o]     2      -1.612       1.623     TYPE(2)
[o]     3      -2.475       1.623     TYPE(3)
[o]     scale parameter taken as  18.35
[o]
[i] ? $tab the mta mean for type$
[o]          1       2       3
[o]    []  3.1404  1.5284  0.6658
[i] ? !type 1 is carpet, 2 is sofa/chair, and 3 is mattress/bed pillow.
[i] ? !This indicates that there is significantly more Der f 1 in carpet
[i] ? !than in sofa/chair or bedding in these study sites.
```

```
[i] ?
[i] ? $yvar mta$fac food 4$error n$link i$fit %gm$dis e$fit +food$dis e$
[w] -- model changed
[o] deviance = 743.85
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
[o]     1       2.044      0.6735     1
[o]     scale parameter taken as  18.60
[o]
[o] deviance = 679.07 (change =  -64.78)
[o]     d.f. =  37    (change =   -3   )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.6676       1.145     1
[o]     2     -0.4695       2.726     FOOD(2)
[o]     3       2.754       1.726     FOOD(3)
[o]     4       2.119       1.650     FOOD(4)
[o]     scale parameter taken as  18.35
[o]
[i] ? $tab the mta mean for food$
[o]          1       2       3       4
[o]    []  0.6676  0.1982  3.4212  2.7868
[i] ? $fit -%gm$dis e$
[o] deviance = 679.07 (change =  0.)
[o]     d.f. =  37    (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.6676       1.145     FOOD(1)
[o]     2      0.1982       2.473     FOOD(2)
[o]     3       3.421       1.292     FOOD(3)
[o]     4       2.787       1.188     FOOD(4)
[o]     scale parameter taken as  18.35
[o]
[i] ? $yvar msf$fac food 4$error n$link i$fit %gm$dis e$fit +food$dis e$
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =    40
[c]
[o]          estimate        s.e.     parameter
[o]     1       13.43       5.198     1
[o]     scale parameter taken as  1108.
[o]
[o] deviance = 41108. (change =  -3206.)
[o]     d.f. =    37  (change =     -3 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       3.651       8.908     1
[o]     2      -2.385       21.21     FOOD(2)
[o]     3       19.89       13.43     FOOD(3)
[o]     4       14.57       12.84     FOOD(4)
[o]     scale parameter taken as  1111.
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 41108. (change =  0.)
[o]     d.f. =    37  (change =  0 )
[o]
[o]          estimate        s.e.     parameter
```

```
[o]      1        3.651        8.908      FOOD(1)
[o]      2        1.266        19.24      FOOD(2)
[o]      3        23.54        10.05      FOOD(3)
[o]      4        18.22        9.245      FOOD(4)
[o]      scale parameter taken as  1111.
[o]
[i] ? $tab the msf mean for food$
[o]            1        2        3        4
[o]     []   3.651    1.266   23.543   18.216
[i] ? $yvar msf$fac food 4$fac type 3$error n$link i$fit %gm$dis e$
[w] -- model changed
[o] deviance = 44313.
[o]      d.f. =     40
[o]
[o]           estimate         s.e.      parameter
[o]      1        13.43        5.198      1
[o]      scale parameter taken as  1108.
[o]
[i] ? $fit +food.type$dis e$
[o] deviance = 38503. (change =  -5810.)
[o]      d.f. =     31  (change =     -9 )
[o]
[o]           estimate         s.e.      parameter
[o]      1        6.960        15.76      1
[o]      2        0.000      aliased      FOOD(1).TYPE(2)
[o]      3       -5.147        19.66      FOOD(1).TYPE(3)
[o]      4       -6.628        38.61      FOOD(2).TYPE(1)
[o]      5       -5.227        29.49      FOOD(2).TYPE(2)
[o]      6        0.000      aliased      FOOD(2).TYPE(3)
[o]      7        27.37        20.64      FOOD(3).TYPE(1)
[o]      8      -0.8147        25.74      FOOD(3).TYPE(2)
[o]      9       -6.757        38.61      FOOD(3).TYPE(3)
[o]     10        15.28        21.34      FOOD(4).TYPE(1)
[o]     11        6.518        21.34      FOOD(4).TYPE(2)
[o]     12        15.56        38.61      FOOD(4).TYPE(3)
[o]      scale parameter taken as  1242.
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 38503. (change =  0.)
[o]      d.f. =     31  (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1        6.960        15.76      FOOD(1).TYPE(1)
[o]      2        0.000      aliased      FOOD(1).TYPE(2)
[o]      3        1.812        11.75      FOOD(1).TYPE(3)
[o]      4       0.3311        35.24      FOOD(2).TYPE(1)
[o]      5        1.733        24.92      FOOD(2).TYPE(2)
[o]      6        0.000      aliased      FOOD(2).TYPE(3)
[o]      7        34.33        13.32      FOOD(3).TYPE(1)
[o]      8        6.145        20.35      FOOD(3).TYPE(2)
[o]      9       0.2025        35.24      FOOD(3).TYPE(3)
[o]     10        22.24        14.39      FOOD(4).TYPE(1)
[o]     11        13.48        14.39      FOOD(4).TYPE(2)
[o]     12        22.52        35.24      FOOD(4).TYPE(3)
[o]      scale parameter taken as  1242.
[o]
[i] ? !The only one that is significant is some food with carpet.
[i]
```

```
[i] ? $tab the msf mean for food;type$
[w] -- the table contains empty cell(s)
[o]           1         2         3
[o]     1   6.9595    0.0000    1.8125
[o]     2   0.3311    1.7329    0.0000
[o]     3  34.3341    6.1448    0.2025
[o]     4  22.2370   13.4778   22.5231
[i] ? $yvar mta$fac food 4$fac type 3$error n$link i$fit %gm$dis e$
[w] -- model changed
[o] deviance = 743.85
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
[o]     1       2.044      0.6735     1
[o]     scale parameter taken as  18.60
[o]
[i] ? $fit +food.type$fit -%gm$dis e$tab the mta mean for food;type$
[o] deviance = 632.91 (change =  -110.9)
[o]     d.f. =  31    (change =    -9  )
[o]
[o] deviance = 632.91 (change =  0.)
[o]     d.f. =  31    (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.315       2.021     FOOD(1).TYPE(1)
[o]     2       0.000     aliased     FOOD(1).TYPE(2)
[o]     3      0.3082       1.506     FOOD(1).TYPE(3)
[o]     4     0.06622       4.518     FOOD(2).TYPE(1)
[o]     5      0.2642       3.195     FOOD(2).TYPE(2)
[o]     6       0.000     aliased     FOOD(2).TYPE(3)
[o]     7       4.716       1.708     FOOD(3).TYPE(1)
[o]     8       1.524       2.609     FOOD(3).TYPE(2)
[o]     9     0.04499       4.518     FOOD(3).TYPE(3)
[o]    10       3.335       1.845     FOOD(4).TYPE(1)
[o]    11       1.952       1.845     FOOD(4).TYPE(2)
[o]    12       4.505       4.518     FOOD(4).TYPE(3)
[o]     scale parameter taken as  20.42
[o]
[w] -- the table contains empty cell(s)
[o]           1         2         3
[o]     1  1.31464  0.00000  0.30819
[o]     2  0.06622  0.26417  0.00000
[o]     3  4.71645  1.52436  0.04499
[o]     4  3.33547  1.95184  4.50462
[i] ? !Same finding as before
[i] ? $yvar msf$fac trap 3$error n$link i$fit %gm$dis e$fit +trap$dis e$
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =    40
[o]
[o]          estimate        s.e.     parameter
[o]     1       13.43       5.198     1
[o]     scale parameter taken as  1108.
```

```
[o]
[o] deviance = 42582.  (change =  -1731.)
[o]     d.f. =    38  (change =     -2 )
[o]
[o]           estimate        s.e.     parameter
[o]      1       5.810       14.97     1
[o]      2      -2.124       18.67     TRAP(2)
[o]      3       12.28       16.30     TRAP(3)
[o]     scale parameter taken as  1121.
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 42582.  (change =  0.)
[o]     d.f. =    38  (change =  0 )
[o]
[o]           estimate        s.e.     parameter
[o]      1       5.810       14.97     TRAP(1)
[o]      2       3.686       11.16     TRAP(2)
[o]      3       18.09       6.442     TRAP(3)
[o]     scale parameter taken as  1121.
[o]
[i] ? $tab the msf mean for trap$
[o]           1       2       3
[o]    []   5.810   3.686  18.091
[i] ? $yvar msf$fac trap 3$fac food 4$error n$link i$fit %gm$dis e$
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =    40
[o]
[o]           estimate        s.e.     parameter
[o]      1       13.43       5.198     1
[o]     scale parameter taken as  1108.
[o]
[i] ? $fit +trap.food$fit -%gm$dis e$tab the msf mean for trap;food$
[o] deviance = 36375.  (change =  -7938.)
[o]     d.f. =    32  (change =     -8 )
[o]
[o] deviance = 36375.  (change =  0.)
[o]     d.f. =    32  (change =  0 )
[o]
[o]           estimate        s.e.     parameter
[o]      1       3.127       23.84     TRAP(1).FOOD(1)
[o]      2       0.000     aliased     TRAP(1).FOOD(2)
[o]      3      0.1364       23.84     TRAP(1).FOOD(3)
[o]      4       22.52       33.72     TRAP(1).FOOD(4)
[o]      5      0.3058       23.84     TRAP(2).FOOD(1)
[o]      6       1.266       19.47     TRAP(2).FOOD(2)
[o]      7       7.192       16.86     TRAP(2).FOOD(3)
[o]      8       0.000     aliased     TRAP(2).FOOD(4)
[o]      9       4.424       10.66     TRAP(3).FOOD(1)
[o]     10       0.000     aliased     TRAP(3).FOOD(2)
[o]     11       45.99       15.08     TRAP(3).FOOD(3)
[o]     12       17.86       9.733     TRAP(3).FOOD(4)
[o]     scale parameter taken as  1137.
[o]
[w] -- the table contains empty cell(s)
[o]           1       2       3       4
[o]      1  3.1268  0.0000  0.1364  22.5231
[o]      2  0.3058  1.2656  7.1920   0.0000
```

```
[o]      3    4.4245    0.0000   45.9869   17.8574
[i] ? $yvar msf$fac trap 3$fac type 3$error n$link i$fit %gm$dis e$
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =     40
[o]
[o]           estimate         s.e.      parameter
[o]      1       13.43        5.198      1
[o]      scale parameter taken as  1108.
[o]
[i] ? $fit +trap.type$dis e$fit -%gm$dis e$tab the msf mean for trap;type$
[o] deviance = 37192. (change =  -7121.)
[o]     d.f. =     34  (change =      -6 )
[o]
[o]           estimate         s.e.      parameter
[o]      1     0.07041        33.07      1
[o]      2       0.000      aliased      TRAP(1).TYPE(2)
[o]      3       7.174        36.98      TRAP(1).TYPE(3)
[o]      4       4.174        35.36      TRAP(2).TYPE(1)
[o]      5       1.662        40.51      TRAP(2).TYPE(2)
[o]      6       0.000      aliased      TRAP(2).TYPE(3)
[o]      7       34.39        34.54      TRAP(3).TYPE(1)
[o]      8       10.96        34.86      TRAP(3).TYPE(2)
[o]      9       1.367        35.36      TRAP(3).TYPE(3)
[o]      scale parameter taken as  1094.
[o]
[o] deviance = 37192. (change =  0.)
[o]     d.f. =     34  (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1     0.07041        33.07      TRAP(1).TYPE(1)
[o]      2       0.000      aliased      TRAP(1).TYPE(2)
[o]      3       7.245        16.54      TRAP(1).TYPE(3)
[o]      4       4.244        12.50      TRAP(2).TYPE(1)
[o]      5       1.733        23.39      TRAP(2).TYPE(2)
[o]      6       0.000      aliased      TRAP(2).TYPE(3)
[o]      7       34.46        9.972      TRAP(3).TYPE(1)
[o]      8       11.03        11.02      TRAP(3).TYPE(2)
[o]      9       1.437        12.50      TRAP(3).TYPE(3)
[o]      scale parameter taken as  1094.
[o]
[w] -- the table contains empty cell(s)
[o]           1        2        3
[o]      1   0.070    0.000    7.245
[o]      2   4.244    1.733    0.000
[o]      3  34.464   11.033    1.437
[i] ? $yvar msf$fac food 4$fac type 3$fac trap 3$error n$link i$fit %gm$dis
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =     40
[o]
[o]           estimate         s.e.      parameter
[o]      1       13.43        5.198      1
[o]      scale parameter taken as  1108.
[o]
[i] ? $fit +trap.type.food$dis e$fit -%gm$dis e$
[o] deviance = 24030. (change =  -20284.)
[o]     d.f. =     27  (change =      -13 )
```

```
[o]
[o]            estimate          s.e.     parameter
[o]       1       1.437         11.28     1
[o]       2       0.000       aliased     TRAP(1).TYPE(1).FOOD(2)
[o]       3      -1.367         31.89     TRAP(1).TYPE(1).FOOD(3)
[o]       4       0.000       aliased     TRAP(1).TYPE(1).FOOD(4)
[o]       5       0.000       aliased     TRAP(1).TYPE(2).FOOD(1)
[o]       6       0.000       aliased     TRAP(1).TYPE(2).FOOD(2)
[o]       7       0.000       aliased     TRAP(1).TYPE(2).FOOD(3)
[o]       8       0.000       aliased     TRAP(1).TYPE(2).FOOD(4)
[o]       9       1.690         23.92     TRAP(1).TYPE(3).FOOD(1)
[o]      10       0.000       aliased     TRAP(1).TYPE(3).FOOD(2)
[o]      11      -1.234         31.89     TRAP(1).TYPE(3).FOOD(3)
[o]      12       21.09         31.89     TRAP(1).TYPE(3).FOOD(4)
[o]      13      -1.131         23.92     TRAP(2).TYPE(1).FOOD(1)
[o]      14      -1.106         31.89     TRAP(2).TYPE(1).FOOD(2)
[o]      15       5.755         18.70     TRAP(2).TYPE(1).FOOD(3)
[o]      16       0.000       aliased     TRAP(2).TYPE(1).FOOD(4)
[o]      17       0.000       aliased     TRAP(2).TYPE(2).FOOD(1)
[o]      18      0.2959         23.92     TRAP(2).TYPE(2).FOOD(2)
[o]      19       0.000       aliased     TRAP(2).TYPE(2).FOOD(3)
[o]      20       0.000       aliased     TRAP(2).TYPE(2).FOOD(4)
[o]      21       0.000       aliased     TRAP(2).TYPE(3).FOOD(1)
[o]      22       0.000       aliased     TRAP(2).TYPE(3).FOOD(2)
[o]      23       0.000       aliased     TRAP(2).TYPE(3).FOOD(3)
[o]      24       0.000       aliased     TRAP(2).TYPE(3).FOOD(4)
[o]      25       9.958         20.59     TRAP(3).TYPE(1).FOOD(1)
[o]      26       0.000       aliased     TRAP(3).TYPE(1).FOOD(2)
[o]      27       104.3         23.92     TRAP(3).TYPE(1).FOOD(3)
[o]      28       20.80         16.60     TRAP(3).TYPE(1).FOOD(4)
[o]      29       0.000       aliased     TRAP(3).TYPE(2).FOOD(1)
[o]      30       0.000       aliased     TRAP(3).TYPE(2).FOOD(2)
[o]      31       4.708         20.59     TRAP(3).TYPE(2).FOOD(3)
[o]      32       12.04         16.60     TRAP(3).TYPE(2).FOOD(4)
[o]      33       0.000       aliased     TRAP(3).TYPE(3).FOOD(1)
[o]      34       0.000       aliased     TRAP(3).TYPE(3).FOOD(2)
[o]      35       0.000       aliased     TRAP(3).TYPE(3).FOOD(3)
[o]      36       0.000       aliased     TRAP(3).TYPE(3).FOOD(4)
[o]     scale parameter taken as  890.0
[o]
[o] deviance = 24030. (change =  0.)
[o]     d.f. =    27  (change =  0 )
[o]
[o]            estimate          s.e.     parameter
[o]       1       0.000       aliased     TRAP(1).TYPE(1).FOOD(1)
[o]       2       0.000       aliased     TRAP(1).TYPE(1).FOOD(2)
[o]       3     0.07041         29.83     TRAP(1).TYPE(1).FOOD(3)
[o]       4       0.000       aliased     TRAP(1).TYPE(1).FOOD(4)
[o]       5       0.000       aliased     TRAP(1).TYPE(2).FOOD(1)
[o]       6       0.000       aliased     TRAP(1).TYPE(2).FOOD(2)
[o]       7       0.000       aliased     TRAP(1).TYPE(2).FOOD(3)
[o]       8       0.000       aliased     TRAP(1).TYPE(2).FOOD(4)
[o]       9       3.127         21.09     TRAP(1).TYPE(3).FOOD(1)
[o]      10       0.000       aliased     TRAP(1).TYPE(3).FOOD(2)
[o]      11      0.2025         29.83     TRAP(1).TYPE(3).FOOD(3)
[o]      12       22.52         29.83     TRAP(1).TYPE(3).FOOD(4)
[o]      13      0.3058         21.09     TRAP(2).TYPE(1).FOOD(1)
[o]      14      0.3311         29.83     TRAP(2).TYPE(1).FOOD(2)
```

```
[o]     15        7.192         14.92      TRAP(2).TYPE(1).FOOD(3)
[o]     16        0.000      aliased       TRAP(2).TYPE(1).FOOD(4)
[o]     17        0.000      aliased       TRAP(2).TYPE(2).FOOD(1)
[o]     18        1.733         21.09      TRAP(2).TYPE(2).FOOD(2)
[o]     19        0.000      aliased       TRAP(2).TYPE(2).FOOD(3)
[o]     20        0.000      aliased       TRAP(2).TYPE(2).FOOD(4)
[o]     21        0.000      aliased       TRAP(2).TYPE(3).FOOD(1)
[o]     22        0.000      aliased       TRAP(2).TYPE(3).FOOD(2)
[o]     23        0.000      aliased       TRAP(2).TYPE(3).FOOD(3)
[o]     24        0.000      aliased       TRAP(2).TYPE(3).FOOD(4)
[o]     25        11.40         17.22      TRAP(3).TYPE(1).FOOD(1)
[o]     26        0.000      aliased       TRAP(3).TYPE(1).FOOD(2)
[o]     27        105.7         21.09      TRAP(3).TYPE(1).FOOD(3)
[o]     28        22.24         12.18      TRAP(3).TYPE(1).FOOD(4)
[o]     29        0.000      aliased       TRAP(3).TYPE(2).FOOD(1)
[o]     30        0.000      aliased       TRAP(3).TYPE(2).FOOD(2)
[o]     31        6.145         17.22      TRAP(3).TYPE(2).FOOD(3)
[o]     32        13.43         12.18      TRAP(3).TYPE(2).FOOD(4)
[o]     33        1.437         11.28      TRAP(3).TYPE(3).FOOD(1)
[o]     34        0.000      aliased       TRAP(3).TYPE(3).FOOD(2)
[o]     35        0.000      aliased       TRAP(3).TYPE(3).FOOD(3)
[o]     36        0.000      aliased       TRAP(3).TYPE(3).FOOD(4)
[o]      scale parameter taken as  890.0
[o]
[i] ? !There is interaction with some food, carpet and high trapping.
[i] ? $fit +food$fit +trap$fit +type$dis e$
[o] deviance = 24030. (change =  0.)
[o]     d.f. =    27  (change =  0 )
[o]
[o] deviance = 24030. (change =  0.)
[o]     d.f. =    27  (change =  0 )
[o]
[o] deviance = 24030. (change =  0.)
[o]     d.f. =    27  (change =  0 )
[o]
[o]           estimate         s.e.     parameter
[o]      1       13.09        29.48     TRAP(1)
[o]      2      0.3058        21.09     TRAP(2)
[o]      3       11.40        17.22     TRAP(3)
[o]      4       7.764        41.94     TYPE(2)
[o]      5      -9.958        20.59     TYPE(3)
[o]      6      -6.337        51.47     FOOD(2)
[o]      7      -13.01        41.94     FOOD(3)
[o]      8      -5.682        46.94     FOOD(4)
[o]      9       0.000      aliased     TRAP(1).TYPE(2).FOOD(2)
[o]     10       0.000      aliased     TRAP(1).TYPE(2).FOOD(3)
[o]     11       0.000      aliased     TRAP(1).TYPE(2).FOOD(4)
[o]     12       0.000      aliased     TRAP(1).TYPE(3).FOOD(2)
[o]     13       10.09        46.94     TRAP(1).TYPE(3).FOOD(3)
[o]     14       25.08        51.47     TRAP(1).TYPE(3).FOOD(4)
[o]     15       6.362        55.62     TRAP(2).TYPE(1).FOOD(2)
[o]     16       19.90        49.26     TRAP(2).TYPE(1).FOOD(3)
[o]     17       0.000      aliased     TRAP(2).TYPE(1).FOOD(4)
[o]     18       0.000      aliased     TRAP(2).TYPE(2).FOOD(1)
[o]     19       0.000      aliased     TRAP(2).TYPE(2).FOOD(2)
[o]     20       0.000      aliased     TRAP(2).TYPE(2).FOOD(3)
[o]     21       0.000      aliased     TRAP(2).TYPE(2).FOOD(4)
[o]     22       0.000      aliased     TRAP(2).TYPE(3).FOOD(1)
```

```
[o]     23        0.000      aliased      TRAP(2).TYPE(3).FOOD(2)
[o]     24        0.000      aliased      TRAP(2).TYPE(3).FOOD(3)
[o]     25        0.000      aliased      TRAP(2).TYPE(3).FOOD(4)
[o]     26        0.000      aliased      TRAP(3).TYPE(1).FOOD(2)
[o]     27        107.4        43.67      TRAP(3).TYPE(1).FOOD(3)
[o]     28        16.52        45.34      TRAP(3).TYPE(1).FOOD(4)
[o]     29        0.000      aliased      TRAP(3).TYPE(2).FOOD(1)
[o]     30        0.000      aliased      TRAP(3).TYPE(2).FOOD(2)
[o]     31        0.000      aliased      TRAP(3).TYPE(2).FOOD(3)
[o]     32        0.000      aliased      TRAP(3).TYPE(2).FOOD(4)
[o]     33        0.000      aliased      TRAP(3).TYPE(3).FOOD(1)
[o]     34        0.000      aliased      TRAP(3).TYPE(3).FOOD(2)
[o]     35        0.000      aliased      TRAP(3).TYPE(3).FOOD(3)
[o]     36        0.000      aliased      TRAP(3).TYPE(3).FOOD(4)
[o]      scale parameter taken as  890.0
[o]
[i] ? $tab the msf mean for food;trap;type$
[w] -- the table contains empty cell(s)
[o]              1           2           3
[o]     1 1    0.00000     0.00000     3.12675
[o]       2    0.30577     0.00000     0.00000
[o]       3   11.39536     0.00000     1.43696
[o]
[o]     2 1    0.00000     0.00000     0.00000
[o]       2    0.33109     1.73289     0.00000
[o]       3    0.00000     0.00000     0.00000
[o]
[o]     3 1    0.07041     0.00000     0.20247
[o]       2    7.19205     0.00000     0.00000
[o]       3  105.74994     6.14480     0.00000
[o]
[o]     4 1    0.00000     0.00000    22.52308
[o]       2    0.00000     0.00000     0.00000
[o]       3   22.23703    13.47782     0.00000
[i] ? $tab the lmsf mean for food;trap;type$
[w] -- the table contains empty cell(s)
[o]              1       2       3
[o]     1 1  0.0000  0.0000  0.2507
[o]       2 -1.4421  0.0000  0.0000
[o]       3  2.2455  0.0000 -0.1144
[o]
[o]     2 1  0.0000  0.0000  0.0000
[o]       2 -1.1054  0.4493  0.0000
[o]       3  0.0000  0.0000  0.0000
[o]
[o]     3 1 -2.6534  0.0000 -1.5972
[o]       2  1.6786  0.0000  0.0000
[o]       3  3.5889  0.6884  0.0000
[o]
[o]     4 1  0.0000  0.0000  3.1145
[o]       2  0.0000  0.0000  0.0000
[o]       3  1.7962  2.1527  0.0000
[i] ? $tab the mta mean for food;trap;type$
[w] -- the table contains empty cell(s)
[o]              1           2           3
[o]     1 1   0.000000    0.000000    0.687161
[o]       2   0.045013    0.000000    0.000000
[o]       3   2.161064    0.000000    0.199915
```

```
[o]
[o]      2 1    0.000000    0.000000    0.000000
[o]        2    0.066217    0.264172    0.000000
[o]        3    0.000000    0.000000    0.000000
[o]
[o]      3 1    0.007041    0.000000    0.044993
[o]        2    1.614152    0.000000    0.000000
[o]        3   13.275763    1.524357    0.000000
[o]
[o]      4 1    0.000000    0.000000    4.504616
[o]        2    0.000000    0.000000    0.000000
[o]        3    3.335466    1.951843    0.000000
[i] ? $tab the msf mean for cat$
[o]           1       2
[o]    []  15.074   5.454
[i] ? $tab the mta mean for cat$
[o]           1       2
[o]    []  2.207  1.252
[i] ? $yvar msf$fac cat 2$error n$link i$fit %gm$dis e$fit +cat$dis e$
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =    40
[o]
[o]           estimate        s.e.     parameter
[o]     1        13.43       5.198     1
[o]     scale parameter taken as  1108.
[o]
[o] deviance = 43776. (change =  -537.2)
[o]     d.f. =    39  (change =    -1  )
[o]
[o]           estimate        s.e.     parameter
[o]     1        15.07       5.746     1
[o]     2       -9.620       13.91     CAT(2)
[o]     scale parameter taken as  1122.
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 43776. (change =  0.)
[o]     d.f. =    39  (change =  0 )
[o]
[o]           estimate        s.e.     parameter
[o]     1        15.07       5.746     CAT(1)
[o]     2        5.454       12.66     CAT(2)
[o]     scale parameter taken as  1122.
[o]
[i] ? !cat = 1 means no cat present; ? means a cat is present
[i] ? !perhaps those with cats vacuum more frequently
[i] ? $yvar msf$fac cat 2$fac type 3$error n$link i$fit %gm$fit +cat.type$di
[w] -- model changed
[o] deviance = 44313.
[o]     d.f. =    40
[o]
[o] deviance = 40376. (change =  -3937.)
[o]     d.f. =    36  (change =     -4 )
[o]
[o]           estimate        s.e.     parameter
[o]     1        25.94       8.647     1
[o]     2       -15.40       14.66     CAT(1).TYPE(2)
[o]     3       -22.39       13.29     CAT(1).TYPE(3)
```

```
[o]      4       -21.01        18.85      CAT(2).TYPE(1)
[o]      5       -19.80        21.18      CAT(2).TYPE(2)
[o]      6        0.000     aliased       CAT(2).TYPE(3)
[o]      scale parameter taken as  1122.
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 40376. (change =  0.)
[o]      d.f. =    36  (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1       25.94        8.647      CAT(1).TYPE(1)
[o]      2       10.54        11.84      CAT(1).TYPE(2)
[o]      3       3.549        10.10      CAT(1).TYPE(3)
[o]      4       4.936        16.74      CAT(2).TYPE(1)
[o]      5       6.145        19.34      CAT(2).TYPE(2)
[o]      6       0.000     aliased       CAT(2).TYPE(3)
[o]      scale parameter taken as  1122.
[o]
[i] ? $yvar msf$fac cat 2$fac type 3$fac trap 3$fac food 4$error n$link i$fi
[w] -- model changed
[o] deviance = 44313.
[o]      d.f. =    40
[o]
[i] ? $fit +cat.trap$dis e$
[o] deviance = 42022. (change =  -2291.)
[o]      d.f. =    35  (change =     -5 )
[o]
[o]           estimate         s.e.      parameter
[o]      1       7.245        17.33      1
[o]      2      -4.994        22.37      CAT(1).TRAP(2)
[o]      3       12.34        18.71      CAT(1).TRAP(3)
[o]      4      -7.174        38.74      CAT(2).TRAP(1)
[o]      5     -0.6868        26.46      CAT(2).TRAP(2)
[o]      6      -1.100        26.46      CAT(2).TRAP(3)
[o]      scale parameter taken as  1201.
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 42022. (change =  0.)
[o]      d.f. =    35  (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1       7.245        17.33      CAT(1).TRAP(1)
[o]      2       2.250        14.15      CAT(1).TRAP(2)
[o]      3       19.58        7.073      CAT(1).TRAP(3)
[o]      4     0.07041        34.65      CAT(2).TRAP(1)
[o]      5       6.558        20.01      CAT(2).TRAP(2)
[o]      6       6.145        20.01      CAT(2).TRAP(3)
[o]      scale parameter taken as  1201.
[o]
[i] ? !It appears that there are interactions where the lack of a cat occurs
[i] ? !with high trapping and with carpet.
[i] ? $stop$
```

APPENDIX 9

ANOVAS FOR FEL D 1

```
[i] ?
[i] ? $yvar csf$fac cat 2$fac type 3$error n$link i$fit %gm$dis e$fit +type$
[o] deviance = 33894158336.
[o]     d.f. =          40
[o]
[o]          estimate        s.e.     parameter
[o]     1        7107.       4546.     1
[o]     scale parameter taken as  847353920.
[o]
[o] deviance = 30015787008. (change =  -3878371328.)
[o]     d.f. =          38  (change =           -2 )
[o]
[i] ? $dis e$
[o]          estimate        s.e.     parameter
[o]     1        1953.       6448.     1
[o]     2       21160.      10648.     TYPE(2)
[o]     3       -1952.      10648.     TYPE(3)
[o]     scale parameter taken as  789889152.
[o]
```

```
[i] ? $fit -%gm$dis e$tab the csf mean for cat;type$
[o] deviance = 30015787008. (change =  0.)
[o]     d.f. =          38  (change =  0 )
```

```
[o]
[o]          estimate          s.e.      parameter
[o]     1       1953.         6448.      TYPE(1)
[o]     2      23114.         8474.      TYPE(2)
[o]     3       1.773         8474.      TYPE(3)
[o]     scale parameter taken as  789889152.
[o]
[w] -- the table contains empty cell(s)
[o]            1           2           3
[o]     1      6.673      26.359       1.773
[o]     2   9253.434   84680.398       0.000
[i] ? $fit +cat.type$dis e$
[o] deviance = 14110200832. (change = -1.591e+10)
[o]     d.f. =          36  (change =     -2    )
[o]
[o]          estimate          s.e.      parameter
[o]     1       6.673         5112.      TYPE(1)
[o]     2       26.36         7000.      TYPE(2)
[o]     3       1.773         5969.      TYPE(3)
[o]     4        9247.       11141.      TYPE(1).CAT(2)
[o]     5       84654.       13403.      TYPE(2).CAT(2)
[o]     6       0.000      aliased       TYPE(3).CAT(2)
[o]     scale parameter taken as  391950016.
[o]
[i] ? !Cats in this study seemed to prefer sofas/chairs.  There is an intera
[i] ? $yvar 1cta$fac cat 2$fac type 3$error n$link i$fit %gm$dis e$fit +type
[w] -- model changed
[o] deviance = 661.92
[o]     d.f. =  40
[o]
[o]          estimate          s.e.      parameter
[o]     1      0.2605        0.6353      1
[o]     scale parameter taken as  16.55
[o]
[o] deviance = 509.03 (change =  -152.9)
[o]     d.f. =  38    (change =    -2  )
[o]
[o]          estimate          s.e.      parameter
[o]     1      0.4765        0.8397      1
[o]     2       2.219         1.387      TYPE(2)
[o]     3      -3.024         1.387      TYPE(3)
[o]     scale parameter taken as  13.40
[o]
[i] ? $fit +cat$dis e$fit +cat.type$dis e$fit -%gm$dis e$
[o] deviance = 138.46 (change =  -370.6)
[o]     d.f. =  37    (change =    -1  )
[o]
[o]          estimate          s.e.      parameter
[o]     1      -1.277        0.4775      1
[o]     2       1.701        0.7347      TYPE(2)
[o]     3      -1.271        0.7538      TYPE(3)
[o]     4       8.331        0.8371      CAT(2)
[o]     scale parameter taken as  3.742
[o]
[o] deviance = 135.21 (change =  -3.245)
[o]     d.f. =  36    (change =  -1    )
[o]
[o]          estimate          s.e.      parameter
```

```
[o]      1       -1.141       0.5004      1
[o]      2        1.309       0.8485      TYPE(2)
[o]      3       -1.407       0.7693      TYPE(3)
[o]      4        7.683        1.091      CAT(2)
[o]      5        1.586        1.706      TYPE(2).CAT(2)
[o]      6        0.000      aliased      TYPE(3).CAT(2)
[o]      scale parameter taken as  3.756
[o]
[o] deviance = 135.21 (change =  0.)
[o]      d.f. =  36    (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1      -1.141       0.5004      TYPE(1)
[o]      2      0.1681       0.6852      TYPE(2)
[o]      3      -2.548       0.5843      TYPE(3)
[o]      4       7.683        1.091      CAT(2)
[o]      5       1.586        1.706      TYPE(2).CAT(2)
[o]      6       0.000      aliased      TYPE(3).CAT(2)
[o]      scale parameter taken as  3.756
[o]
[i] ? !With the logarithmic data of Fel d 1 per time*area, there is signific
[i] ? !for carpet, for mattress, for presence of a cat, but no interaction.
[i] ? $yvar lcsf$fac cat 2$fac type 3$error n$link i$fit %gm$dis e$fit +cat$
[w] -- model changed
[o] deviance = 641.99
[o]      d.f. =  40
[o]
[o]           estimate         s.e.      parameter
[o]      1       2.045       0.6257      1
[o]      scale parameter taken as  16.05
[o]
[o] deviance = 184.57 (change =  -457.4)
[o]      d.f. =  39    (change =    -1  )
[o]
[o]           estimate         s.e.      parameter
[o]      1      0.5293       0.3731      1
[o]      2       8.877       0.9029      CAT(2)
[o]      scale parameter taken as  4.733
[o]
[i] ? $fit +type$dis e$fit +type.cat$dis e$fit -%gm$dis e$
[o] deviance = 138.45 (change =  -46.12)
[o]      d.f. =  37    (change =   -2   )
[o]
[o]           estimate         s.e.      parameter
[o]      1      0.5366       0.4775      1
[o]      2       8.136       0.8371      CAT(2)
[o]      3       1.711       0.7347      TYPE(2)
[o]      4      -1.267       0.7538      TYPE(3)
[o]      scale parameter taken as  3.742
[o]
[o] deviance = 136.15 (change =  -2.297)
[o]      d.f. =  36    (change =  -1    )
[o]
[o]           estimate         s.e.      parameter
[o]      1      0.6514       0.5021      1
[o]      2       7.591        1.094      CAT(2)
[o]      3       1.381       0.8514      TYPE(2)
[o]      4      -1.382       0.7720      TYPE(3)
```

```
[o]      5        1.334        1.712      CAT(2).TYPE(2)
[o]      6        0.000      aliased      CAT(2).TYPE(3)
[o]      scale parameter taken as  3.782
[o]
[o] deviance = 136.15 (change =  0.)
[o]      d.f. =  36    (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1      0.6514       0.5021      CAT(1)
[o]      2       8.242       0.9724      CAT(2)
[o]      3       1.381       0.8514      TYPE(2)
[o]      4      -1.382       0.7720      TYPE(3)
[o]      5       1.334        1.712      CAT(2).TYPE(2)
[o]      6       0.000      aliased      CAT(2).TYPE(3)
[o]      scale parameter taken as  3.782
[o]
[i] ? !Find just presence of a cat to be significant with Fel d 1 per sq ft
[i] ? $yvar csf$fac cat 2$fac type 3$error n$link i$fit %gm$dis e$fit +cat$d
[w] -- model changed
[o] deviance = 33894158336.
[o]      d.f. =          40
[o]
[o]           estimate         s.e.      parameter
[o]      1       7107.        4546.      1
[o]      scale parameter taken as  847353920.
[o]
[o] deviance = 23863164928. (change = -1.003e+10)
[o]      d.f. =          39  (change =     -1    )
[o]
[o]           estimate         s.e.      parameter
[o]      1       9.720        4242.      1
[o]      2      41570.       10267.      CAT(2)
[o]      scale parameter taken as  611876032.
[o]
[i] ? $fit +type$dis e$fit +type.cat$dis e$fit -%gm$dis e$
[o] deviance = 21447307264. (change =  -2415857664.)
[o]      d.f. =          37  (change =           -2 )
[o]
[o]           estimate         s.e.      parameter
[o]      1      -6480.        5943.      1
[o]      2      40058.       10419.      CAT(2)
[o]      3      18669.        9145.      TYPE(2)
[o]      4       6482.        9382.      TYPE(3)
[o]      scale parameter taken as  579656960.
[o]
[o] deviance = 14110200832. (change =  -7337106432.)
[o]      d.f. =          36  (change =           -1 )
[o]
[o]           estimate         s.e.      parameter
[o]      1       6.673        5112.      1
[o]      2       9247.       11141.      CAT(2)
[o]      3       19.69        8667.      TYPE(2)
[o]      4      -4.899        7859.      TYPE(3)
[o]      5      75407.       17429.      CAT(2).TYPE(2)
[o]      6       0.000      aliased      CAT(2).TYPE(3)
[o]      scale parameter taken as  391950016.
[o]
[o] deviance = 14110200832. (change =  0.)
```

```
[o]     d.f. =          36  (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       6.673       5112.     CAT(1)
[o]     2        9253.      9899.     CAT(2)
[o]     3        19.69      8667.     TYPE(2)
[o]     4      -4.899       7859.     TYPE(3)
[o]     5       75407.     17429.     CAT(2).TYPE(2)
[o]     6        0.000    aliased     CAT(2).TYPE(3)
[o]     scale parameter taken as  391950016.
[o]
[i] ? !For straight Fel d 1 per sq ft there is a relationship with only an
[i] ? !interaction between cats present and sofa/chair.
[i] ? $yvar cta$fac cat 2 fac type 3$error n$link i$fit %gm$dis e$
[w] -- model changed
[o] deviance = 2112696448.
[o]     d.f. =         40
[o]
[o]          estimate        s.e.     parameter
[o]     1       1728.       1135.     1
[o]     scale parameter taken as  52817412.
[o]
[o] deviance = 1519357696. (change =  -593338752.)
[o]     d.f. =         39  (change =          -1 )
[o]
```

```
[i] ? $fit +cat$dis e$fit +type$dis e$fit +cat.type$dis e$fit -%gm$dis e$
[o] deviance = 1519357696. (change =  0.)
[o]     d.f. =         39  (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.393       1070.     1
[o]     2      10110.       2591.     CAT(2)
[o]     scale parameter taken as  38957892.
[o]
[o] deviance = 1374758656. (change =  -144599040.)
[o]     d.f. =         37  (change =          -2 )
[o]
[o]          estimate        s.e.     parameter
[o]     1      -1587.       1505.     1
[o]     2       9741.       2638.     CAT(2)
[o]     3       4567.       2315.     TYPE(2)
[o]     4       1587.       2375.     TYPE(3)
[o]     scale parameter taken as  37155640.
[o]
[o] deviance = 935113408. (change =  -439645248.)
[o]     d.f. =        36  (change =          -1 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.132       1316.     1
[o]     2       2198.       2868.     CAT(2)
[o]     3       2.278       2231.     TYPE(2)
[o]     4     -0.8503       2023.     TYPE(3)
```

```
[o]     5      18459.        4487.     CAT(2).TYPE(2)
[o]     6       0.000     aliased      CAT(2).TYPE(3)
[o]     scale parameter taken as  25975372.
[o]
[o] deviance = 935113408. (change =  0.)
[o]     d.f. =        36  (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.132       1316.     CAT(1)
[o]     2       2200.       2548.     CAT(2)
[o]     3       2.278       2231.     TYPE(2)
[o]     4     -0.8503       2023.     TYPE(3)
[o]     5       18459.      4487.     CAT(2).TYPE(2)
[o]     6       0.000     aliased     CAT(2).TYPE(3)
[o]     scale parameter taken as  25975372.
[o]
[i] ? !With straight Fel d 1 per sf*min there is only significance with the
[i] ? !interaction between having a cat and sofa/chair.
[i] ? $tab the cta mean for cat;type$
[w] -- the table contains empty cell(s)
[o]             1           2           3
[o]     1      1.1325      3.4103      0.2821
[o]     2   2199.6133  20660.6309      0.0000
[i] ? $yvar cta$fac cat 2$fac trap 3$error n$link i$fit %gm$dis e$fit +cat$d
[w] -- model changed
[o] deviance = 2112696448.
[o]     d.f. =         40
[o]
[o]          estimate        s.e.     parameter
[o]     1       1728.       1135.     1
[o]     scale parameter taken as  52817412.
[o]
[o] deviance = 1519357696. (change =  -593338752.)
[o]     d.f. =         39  (change =          -1 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.393       1070.     1
[o]     2       10110.      2591.     CAT(2)
[o]     scale parameter taken as  38957892.
[o]
[i] ? $fit +trap$dis e$fit -%gm$dis e$tab the cta mean for cat;trap$fit +cat
[o] deviance = 1404322432. (change =  -115035264.)
[o]     d.f. =         37  (change =          -2 )
[o]
[o]          estimate        s.e.     parameter
[o]     1      -2225.       2805.     1
[o]     2       11151.      2635.     CAT(2)
[o]     3      -516.6       3454.     TRAP(2)
[o]     4       3283.       3009.     TRAP(3)
[o]     scale parameter taken as  37954660.
[o]
[o] deviance = 1404322432. (change =  0.)
[o]     d.f. =         37  (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1      -2225.       2805.     CAT(1)
[o]     2       8926.       3469.     CAT(2)
[o]     3      -516.6       3454.     TRAP(2)
```

```
[o]     4        3283.        3009.      TRAP(3)
[o]     scale parameter taken as  37954660.
[o]
[o]             1           2           3
[o]     1       0.269       1.594       1.531
[o]     2      26.596    2923.952   20660.631
[o] deviance = 928817408. (change =  -475505024.)
[o]     d.f. =         35  (change =          -2 )
[o]
[i] ? $dis e$
[o]           estimate         s.e.      parameter
[o]     1       0.2693        2576.      CAT(1)
[o]     2        26.60        5151.      CAT(2)
[o]     3        1.325        3325.      TRAP(2)
[o]     4        1.261        2782.      TRAP(3)
[o]     5        2896.        6815.      CAT(2).TRAP(2)
[o]     6       20633.        6567.      CAT(2).TRAP(3)
[o]     scale parameter taken as  26537640.
[o]
[i] ? !There is an interaction between having a cat and high trapping of the
[i] ? $yvar csf$fac cat 2$fac trap 3$error n$link i$fit %gm$dis E$fit +cat$d
[w] -- model changed
[o] deviance = 33894158336.
[o]     d.f. =          40
[o]
[o]           estimate         s.e.      parameter
[o]     1        7107.        4546.      1
[o]     scale parameter taken as  847353920.
[o]
[o] deviance = 23863164928. (change = -1.003e+10)
[o]     d.f. =          39  (change =     -1     )
[o]
[o]           estimate         s.e.      parameter
[o]     1        9.720        4242.      1
[o]     2       41570.       10267.      CAT(2)
[o]     scale parameter taken as  611876032.
[o]
[i] ? $fit +trap$dis e$fit +trap.cat$dis e$tab the csf mean for cat;trap$
[o] deviance = 21942988800. (change =  -1920176128.)
[o]     d.f. =          37  (change =          -2 )
[o]
[o]           estimate         s.e.      parameter
[o]     1       -9109.       11088.      1
[o]     2       45818.       10416.      CAT(2)
[o]     3       -2073.       13654.      TRAP(2)
[o]     4       13437.       11893.      TRAP(3)
[o]     scale parameter taken as  593053760.
[o]
[o] deviance = 14002504704. (change =  -7940484096.)
[o]     d.f. =          35  (change =          -2 )
[o]
[o]           estimate         s.e.      parameter
[o]     1        1.297       10001.      1
[o]     2        264.7       22363.      CAT(2)
[o]     3        9.756       12911.      TRAP(2)
[o]     4        9.493       10802.      TRAP(3)
[o]     5       11974.       26460.      CAT(2).TRAP(2)
[o]     6       84405.       25497.      CAT(2).TRAP(3)
```

```
[o]     scale parameter taken as  400071552.
[o]
[o]            1          2          3
[o]     1       1.30      11.05      10.79
[o]     2     265.96   12249.26   84680.40
[i] ? !There is interaction between having a cat and high surface trapping.
[i] ? $yvar cta$fac food 4$fac cat 2$error n$link i$fit %gm$dis e$fit +cat$d
[w] -- model changed
[o] deviance = 2112696448.
[o]     d.f. =          40
[o]
[o]           estimate         s.e.     parameter
[o]     1         1728.        1135.     1
[o]     scale parameter taken as  52817412.
[o]
[o] deviance = 1519357696. (change =  -593338752.)
[o]     d.f. =          39  (change =          -1 )
[o]
[o]           estimate         s.e.     parameter
[o]     1        1.393        1070.     1
[o]     2        10110.       2591.     CAT(2)
[o]     scale parameter taken as  38957892.
[o]
[i] ? $fit +food$dis e$fit +food.cat$dis e$fit -%gm$dis E$
[o] deviance = 1519357696. (change =  0.)
[o]     d.f. =          36  (change = -3 )
[o]
[o]           estimate         s.e.     parameter
[o]     1       0.8895        1736.     1
[o]     2       10111.        4072.     CAT(2)
[o]     3        2.127        4133.     FOOD(2)
[o]     4      -0.7302        3683.     FOOD(3)
[o]     5        1.052        2502.     FOOD(4)
[o]     scale parameter taken as  42204380.
[o]
[o] deviance = 1519357696. (change =  0.)
[o]     d.f. =          36  (change =  0 )
[o]
[o]           estimate         s.e.     parameter
[o]     1       0.8895        1736.     1
[o]     2       10111.        4072.     CAT(2)
[o]     3        2.127        4133.     FOOD(2)
[o]     4      -0.7302        3683.     FOOD(3)
[o]     5        1.052        2502.     FOOD(4)
[o]     6        0.000     aliased      CAT(2).FOOD(2)
[o]     7        0.000     aliased      CAT(2).FOOD(3)
[o]     8        0.000     aliased      CAT(2).FOOD(4)
[o]     scale parameter taken as  42204380.
[o]
[o] deviance = 1519357696. (change =  0.)
[o]     d.f. =          36  (change =  0 )
[o]
[o]           estimate         s.e.     parameter
[o]     1       0.8895        1736.     CAT(1)
[o]     2       10112.        4427.     CAT(2)
[o]     3        2.127        4133.     FOOD(2)
[o]     4      -0.7302        3683.     FOOD(3)
[o]     5        1.052        2502.     FOOD(4)
```

```
[o]      6        0.000      aliased      CAT(2).FOOD(2)
[o]      7        0.000      aliased      CAT(2).FOOD(3)
[o]      8        0.000      aliased      CAT(2).FOOD(4)
[o]      scale parameter taken as  42204380.
[o]


[i] ? !Presence of food is irrelevant to Fel d 1 presence
[i] ? $tab the csf mean for cat;food$
[w] -- the table contains empty cell(s)
[o]              1           2           3           4
[o]      1       4.780      21.062       1.116      15.069
[o]      2       0.000       0.000   41579.277       0.000
[i] ? $yvar cta$fac cat 2$fac trap 3$fac type 3$error n$link i$fit %gm$dis e
[w] -- model changed
[o] deviance = 2112696448.
[o]      d.f. =          40
[o]
[o]           estimate         s.e.      parameter
[o]      1        1728.        1135.      1
[o]      scale parameter taken as  52817412.
[o]
[i] ? $fit +cat.trap.type$dis e$fit -%gm$dis e$
[o] deviance = 928817344. (change =  -1183879168.)
[o]      d.f. =         32  (change =           -8 )
[o]
[o]           estimate         s.e.      parameter
[o]      1       20661.        3110.      1
[o]      2        0.000      aliased      CAT(1).TRAP(1).TYPE(2)
[o]      3      -20660.        4115.      CAT(1).TRAP(1).TYPE(3)
[o]      4      -20661.        4115.      CAT(1).TRAP(2).TYPE(1)
[o]      5      -20656.        4918.      CAT(1).TRAP(2).TYPE(2)
[o]      6        0.000      aliased      CAT(1).TRAP(2).TYPE(3)
[o]      7      -20659.        3509.      CAT(1).TRAP(3).TYPE(1)
[o]      8      -20658.        3810.      CAT(1).TRAP(3).TYPE(2)
[o]      9      -20660.        3718.      CAT(1).TRAP(3).TYPE(3)
[o]     10      -20634.        6221.      CAT(2).TRAP(1).TYPE(1)
[o]     11        0.000      aliased      CAT(2).TRAP(1).TYPE(2)
[o]     12        0.000      aliased      CAT(2).TRAP(1).TYPE(3)
[o]     13      -17737.        4399.      CAT(2).TRAP(2).TYPE(1)
[o]     14        0.000      aliased      CAT(2).TRAP(2).TYPE(2)
[o]     15        0.000      aliased      CAT(2).TRAP(2).TYPE(3)
[o]     16        0.000      aliased      CAT(2).TRAP(3).TYPE(1)
[o]     17        0.000      aliased      CAT(2).TRAP(3).TYPE(2)
[o]     18        0.000      aliased      CAT(2).TRAP(3).TYPE(3)
[o]      scale parameter taken as  29025542.
[o]
[o] deviance = 928817344. (change =  0.)
[o]      d.f. =         32  (change =  0 )
[o]
[o]           estimate         s.e.      parameter
[o]      1        0.000      aliased      CAT(1).TRAP(1).TYPE(1)
[o]      2        0.000      aliased      CAT(1).TRAP(1).TYPE(2)
[o]      3       0.2693        2694.      CAT(1).TRAP(1).TYPE(3)
[o]      4       0.1303        2694.      CAT(1).TRAP(2).TYPE(1)
```

```
[o]      5        4.521        3810.     CAT(1).TRAP(2).TYPE(2)
[o]      6        0.000     aliased      CAT(1).TRAP(2).TYPE(3)
[o]      7        1.497        1624.     CAT(1).TRAP(3).TYPE(1)
[o]      8        3.040        2199.     CAT(1).TRAP(3).TYPE(2)
[o]      9       0.2895        2036.     CAT(1).TRAP(3).TYPE(3)
[o]     10        26.60        5388.     CAT(2).TRAP(1).TYPE(1)
[o]     11        0.000     aliased      CAT(2).TRAP(1).TYPE(2)
[o]     12        0.000     aliased      CAT(2).TRAP(1).TYPE(3)
[o]     13        2924.        3110.     CAT(2).TRAP(2).TYPE(1)
[o]     14        0.000     aliased      CAT(2).TRAP(2).TYPE(2)
[o]     15        0.000     aliased      CAT(2).TRAP(2).TYPE(3)
[o]     16        0.000     aliased      CAT(2).TRAP(3).TYPE(1)
[o]     17       20661.        3110.     CAT(2).TRAP(3).TYPE(2)
[o]     18        0.000     aliased      CAT(2).TRAP(3).TYPE(3)
[o]      scale parameter taken as  29025542.
[o]
[i] ? !Having a cat, high trapping, and sofa/chair is a significant interact
[i] ? $tab the cta mean for cat;trap;type$
[w] -- the table contains empty cell(s)
[o]                1            2            3
[o]     1 1        0.0000       0.0000       0.2693
[o]       2        0.1303       4.5210       0.0000
[o]       3        1.4969       3.0401       0.2895
[o]
[o]     2 1       26.5961       0.0000       0.0000
[o]       2     2923.9524       0.0000       0.0000
[o]       3        0.0000   20660.6309       0.0000
[i] ? $tab the csf mean for cat;trap;type$
[w] -- the table contains empty cell(s)
[o]                1            2            3
[o]     1 1        0.0000       0.0000       1.2972
[o]       2        0.7915      31.5766       0.0000
[o]       3        8.8111      24.6194       2.0453
[o]
[o]     2 1      265.9615       0.0000       0.0000
[o]       2    12249.2578       0.0000       0.0000
[o]       3        0.0000   84680.3984       0.0000
[i] ? $stop$
```

APPENDIX 10

LINEAR REGRESSION/ANCOVA

DER F 1 VS FEL D 1

```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vac2.doc
[i] $subfile a:vac2.doc
[i] $units 41$
[i] !This is a data set of all vacuum samples which were collected then
[i] !determined to have sufficient mass to be analyzed by the DACI Lab.
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/surface. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328       767   97    8      115.1  3    3       1    1
[i] 2  0.245       1156  57    8      60      1    3       1  1
[i] 3  0.227       118   997   7      19     3     3       1    1
[i] 4  0.227       116   132   7      52.7   1     2       1    1
[i] 5  0.621       60   563    5     37.5    2     2       1    2
[i] 6  0.063       247   25    5     47      1     2       1    2
[i] 7  0.159       25    157   8     37.5    3     3       1    1
[i] 8  0.179      25     557   6     40      1     2       1    1
[i] 9  0.135   54  2323180     6     17.1    2     3       2    3
[i] 10  0.034  70    264397    10    33.8    1    1        2    3
[i] 11  0.696    318   3323    8.5  23.125   2    3        1    4
[i] 12  0.099    222     2281  7.5  14.6    1    3         1    4
[i] 13  0.247   1167    202    7    76.7     3    3        1    1
[i] 14   0.338  168    97    4.5    9.5     3     1       1    1
[i] 15  0.621   175    228    5     12.75   1    3        1    1
[i] 16  0.886   25    25     5     12      1   3          1    4
[i] 17   0.083  25   207     4     8.7      1    3        1    4
[i] 18  0.322   373   25       5   6.4     2   3          1    4
[i] 19  0.087  836  8777972  4     4.3     2    3         2    3
[i] 20  0.024  5718  1830677   5    9.9    1  2           2    3
[i] 21  0.068  301   613       5    13    2   3           1    4
[i] 22  1.302   513   229     7     19.4   1   3          1    4
[i] 23   0.393  208   124     7      12.8   1  3          1    3
[i] 24   0.020  205   25      4.5    20.25  3  1          1    3
[i] 25  0.219   20886  57   8     22.3    1   3          1    3
[i] 26  0.034   3183   25   4    11.9   1    2           1    3
[i] 27  0.038    201   25   4    26.2   3     3          1    1
[i] 28  0.949   62    1350  7.5  23.8   2   2            1    2
[i] 29   0.145   115   25   9    19.0  3   3             1    1
[i] 30  0.148    371    152  7    38.4   3   3           1    1
[i] 32  0.152  59   3134314  4    8.2    2   3           2    3
[i] 33  1.029  25  147843    4     6.0   1  2            2    3
[i] 34  0.372  25  114042      4.5   6.1  1  2           2    3
[i] 35  0.036  548   25      7     6.4   2  3            1    4
[i] 36  0.992   190   305   5    9.0    1  3             1    1
[i] 37  0.040   125   514   6    18.1   3   1            1    1
[i] 39  0.180   976   25    5     7.8    3   1           1    4
[i] 41  0.3138  1233  1051  9   11.3    2   3           1    4
[i] 42  0.2433   1657  461  8   11.7   1    3           1    4
[i] 44  0.4155  292   298   6   8.9   2    3            1    4
[i] 45  1.3827   454    25  6   10.3  1   3             1    4
```

```
[i]
[i] $finish$
[i] ? $calc mtot=mngg*dtot$calc lmt=%log mtot$calc ldt=%log dtot$
[i] ? $calc ctot=cngg*dtot$calc lct=%log ctot$
[i] ? $plot mtot ctot$
[o]     5000. |
[o]     4750. |
[o]     4500. M
[o]     4250. |
[o]     4000. |
[o]     3750. |
[o]     3500. |
[o]     3250. |
[o]     3000. |
[o]     2750. |
[o]     2500. |
[o]     2250. |
[o]     2000. |
[o]     1750. |
[o]     1500. |
[o]     1250. |
[o]     1000. |
[o]      750. 2
[o]      500. 2
[o]      250. 6  M
[o]        0. 9M M      M         M         M                  M
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]            0.   160000.   320000.   480000.   640000.   800000.   960000
[i] ? $plot lct lmt$
[o]    14.400 |
[o]    13.600 |                           L
[o]    12.800 |             L L
[o]    12.000 |                     L
[o]    11.200 |
[o]    10.400 |               L                 L
[o]     9.600 |
[o]     8.800 |     L
[o]     8.000 |                                   L
[o]     7.200 |                         L
[o]     6.400 |
[o]     5.600 |                   L L L           L   L   L
[o]     4.800 |         L                     LL      L
[o]     4.000 |                   L         L       L
[o]     3.200 |     L   LL        LL    2           L     L
[o]     2.400 |                                 L     L                   L
[o]     1.600 |                   L               L
[o]     0.800 |                  L
[o]     0.000 |              L     L          L
[o]    -0.800 |         L
[o]    -1.600 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         0.00      1.60      3.20      4.80      6.40      8.00      9.60
[i] ? $yvar lmt$fac type 3$fac trap 3$fac cat 2$fac food 4$error n$link i$
[i] ? $fit %gm$dis e$fit +lct$dis e$fit +cat$dis e$fit +trap$dis e$
[o] deviance = 123.45
[o]     d.f. =  40
[o]
[o]          estimate        s.e.     parameter
```

```
[o]     1        3.848       0.2744      1
[o]     scale parameter taken as  3.086
[o]
[o] deviance = 122.97 (change = -0.4764)
[o]     d.f. =  39    (change = -1     )
[o]
[o]          estimate         s.e.      parameter
[o]     1       3.992       0.4614      1
[o]     2    -0.02942      0.07569      LCT
[o]     scale parameter taken as  3.153
[o]
[o] deviance = 103.10 (change =  -19.87)
[o]     d.f. =  38    (change =   -1   )
[o]
[o]          estimate         s.e.      parameter
[o]     1       3.135       0.5323      1
[o]     2      0.2662       0.1299      LCT
[o]     3      -3.422        1.265      CAT(2)
[o]     scale parameter taken as  2.713
[o]
[o] deviance = 98.143 (change =  -4.960)
[o]     d.f. = 36     (change =  -2    )
[o]
[o]          estimate         s.e.      parameter
[o]     1       2.504       0.7846      1
[o]     2      0.2010       0.1396      LCT
[o]     3      -2.728        1.368      CAT(2)
[o]     4      0.5516       0.9544      TRAP(2)
[o]     5       1.077       0.8643      TRAP(3)
[o]     scale parameter taken as  2.726
[o]
[i] ? $fit +type$dis e$fit +food$dis e$
[o] deviance = 93.540 (change =  -4.603)
[o]     d.f. = 34     (change =  -2    )
[o]
[o]          estimate         s.e.      parameter
[o]     1       3.209        1.033      1
[o]     2      0.2080       0.1490      LCT
[o]     3      -2.897        1.395      CAT(2)
[o]     4    -0.01108        1.085      TRAP(2)
[o]     5      0.7750       0.9345      TRAP(3)
[o]     6     -0.5761       0.6745      TYPE(2)
[o]     7     -0.8670       0.7463      TYPE(3)
[o]     scale parameter taken as  2.751
[o]
[o] deviance = 85.107 (change =  -8.433)
[o]     d.f. = 31     (change =  -3    )
[o]
[o]          estimate         s.e.      parameter
[o]     1       1.770        1.442      1
[o]     2      0.3137       0.1606      LCT
[o]     3      -4.935        1.887      CAT(2)
[o]     4      0.6101        1.246      TRAP(2)
[o]     5       1.067       0.9741      TRAP(3)
[o]     6     -0.6154       0.7745      TYPE(2)
[o]     7     -0.1206       0.9479      TYPE(3)
[o]     8      0.1011        1.474      FOOD(2)
[o]     9       1.870        1.098      FOOD(3)
```

```
[o]     10       0.7694       0.8884      FOOD(4)
[o]      scale parameter taken as  2.745
[o]
[i] ? $fit +food.type$dis e$fit +food.trap$dis e$fit +cat.type$dis e$
[o] deviance = 69.452 (change =  -15.65)
[o]     d.f. = 27     (change =   -4   )
[o]
[o]           estimate        s.e.     parameter
[o]      1       1.487       1.450     1
[o]      2      0.3518      0.1752     LCT
[o]      3      -5.091       2.073     CAT(2)
[o]      4      0.3216       1.269     TRAP(2)
[o]      5       1.589       1.115     TRAP(3)
[o]      6      0.2535      0.9267     TYPE(2)
[o]      7     -0.4005       1.016     TYPE(3)
[o]      8      0.7759       1.958     FOOD(2)
[o]      9       2.452       1.236     FOOD(3)
[o]     10     -0.2508       1.058     FOOD(4)
[o]     11      -1.281       2.433     TYPE(2).FOOD(2)
[o]     12      -2.474       1.818     TYPE(2).FOOD(3)
[o]     13       0.000     aliased     TYPE(2).FOOD(4)
[o]     14       0.000     aliased     TYPE(3).FOOD(2)
[o]     15      -1.884       2.246     TYPE(3).FOOD(3)
[o]     16       3.803       2.226     TYPE(3).FOOD(4)
[o]      scale parameter taken as  2.572
[o]
[o] deviance = 63.984 (change =  -5.468)
[o]     d.f. = 25     (change =  -2    )
[o]
[o]           estimate        s.e.     parameter
[o]      1       2.923       1.813     1
[o]      2      0.3267      0.1855     LCT
[o]      3      -4.895       2.788     CAT(2)
[o]      4      -1.845       1.949     TRAP(2)
[o]      5      0.8197       1.284     TRAP(3)
[o]      6      0.2483      0.9245     TYPE(2)
[o]      7      -1.163       1.140     TYPE(3)
[o]      8       1.519       2.067     FOOD(2)
[o]      9     -0.1352       3.182     FOOD(3)
[o]     10       2.917       1.986     FOOD(4)
[o]     11       0.000     aliased     TRAP(2).FOOD(2)
[o]     12       3.795       2.730     TRAP(2).FOOD(3)
[o]     13       0.000     aliased     TRAP(2).FOOD(4)
[o]     14       0.000     aliased     TRAP(3).FOOD(2)
[o]     15       1.761       3.165     TRAP(3).FOOD(3)
[o]     16      -3.728       2.280     TRAP(3).FOOD(4)
[o]     17      -1.124       2.458     TYPE(2).FOOD(2)
[o]     18      -2.177       2.539     TYPE(2).FOOD(3)
[o]     19       0.000     aliased     TYPE(2).FOOD(4)
[o]     20       0.000     aliased     TYPE(3).FOOD(2)
[o]     21     0.01220       3.171     TYPE(3).FOOD(3)
[o]     22       0.000     aliased     TYPE(3).FOOD(4)
[o]      scale parameter taken as  2.559
[o]
[o] deviance = 63.984 (change =  0.)
[o]     d.f. = 25     (change =  0 )
[o]
[o]           estimate        s.e.     parameter
```

```
[o]      1        2.923        1.813     1
[o]      2       0.3267       0.1855     LCT
[o]      3       -4.895        2.788     CAT(2)
[o]      4       -1.845        1.949     TRAP(2)
[o]      5       0.8197        1.284     TRAP(3)
[o]      6       0.2483       0.9245     TYPE(2)
[o]      7       -1.163        1.140     TYPE(3)
[o]      8        1.519        2.067     FOOD(2)
[o]      9      -0.1352        3.182     FOOD(3)
[o]     10        2.917        1.986     FOOD(4)
[o]     11       -2.177        2.539     CAT(2).TYPE(2)
[o]     12        0.000      aliased     CAT(2).TYPE(3)
[o]     13        0.000      aliased     TRAP(2).FOOD(2)
[o]     14        3.795        2.730     TRAP(2).FOOD(3)
[o]     15        0.000      aliased     TRAP(2).FOOD(4)
[o]     16        0.000      aliased     TRAP(3).FOOD(2)
[o]     17        1.761        3.165     TRAP(3).FOOD(3)
[o]     18       -3.728        2.280     TRAP(3).FOOD(4)
[o]     19       -1.124        2.458     TYPE(2).FOOD(2)
[o]     20        0.000      aliased     TYPE(2).FOOD(3)
[o]     21        0.000      aliased     TYPE(2).FOOD(4)
[o]     22        0.000      aliased     TYPE(3).FOOD(2)
[o]     23      0.01220        3.171     TYPE(3).FOOD(3)
[o]     24        0.000      aliased     TYPE(3).FOOD(4)
[o]     scale parameter taken as  2.559
[o]
[i] ? $fit +trap.type$dis e$
[o] deviance = 63.984 (change =  0.)
[o]     d.f. = 25     (change =  0 )
[o]
[o]           estimate         s.e.     parameter
[o]      1       2.911        3.150     1
[o]      2      0.3267       0.1855     LCT
[o]      3      -4.895        2.788     CAT(2)
[o]      4      -1.833        3.355     TRAP(2)
[o]      5      0.8319        3.302     TRAP(3)
[o]      6      0.2483       0.9245     TYPE(2)
[o]      7      -1.150        2.933     TYPE(3)
[o]      8       1.519        2.067     FOOD(2)
[o]      9     -0.1230        2.092     FOOD(3)
[o]     10       2.917        1.986     FOOD(4)
[o]     11      -2.177        2.539     CAT(2).TYPE(2)
[o]     12       0.000      aliased     CAT(2).TYPE(3)
[o]     13      -1.124        2.458     TRAP(2).TYPE(2)
[o]     14       0.000      aliased     TRAP(2).TYPE(3)
[o]     15       0.000      aliased     TRAP(3).TYPE(2)
[o]     16    -0.01220        3.171     TRAP(3).TYPE(3)
[o]     17       0.000      aliased     TRAP(2).FOOD(2)
[o]     18       3.783        2.771     TRAP(2).FOOD(3)
[o]     19       0.000      aliased     TRAP(2).FOOD(4)
[o]     20       0.000      aliased     TRAP(3).FOOD(2)
[o]     21       1.749        2.495     TRAP(3).FOOD(3)
[o]     22      -3.728        2.280     TRAP(3).FOOD(4)
[o]     23       0.000      aliased     TYPE(2).FOOD(2)
[o]     24       0.000      aliased     TYPE(2).FOOD(3)
[o]     25       0.000      aliased     TYPE(2).FOOD(4)
[o]     26       0.000      aliased     TYPE(3).FOOD(2)
[o]     27       0.000      aliased     TYPE(3).FOOD(3)
```

```
[o]    28        0.000      aliased      TYPE(3).FOOD(4)
[o]     scale parameter taken as  2.559
[o]
[i] ? $fit +cat.trap$dis e$
[o] deviance = 63.984 (change =  0.)
[o]     d.f. = 25     (change =  0 )
[o]
[o]           estimate        s.e.      parameter
[o]     1        2.923       1.813      1
[o]     2       0.3267      0.1855      LCT
[o]     3       -4.907       2.948      CAT(2)
[o]     4       -1.845       1.949      TRAP(2)
[o]     5       0.8197       1.284      TRAP(3)
[o]     6       0.2483      0.9245      TYPE(2)
[o]     7       -1.163       1.140      TYPE(3)
[o]     8        1.519       2.067      FOOD(2)
[o]     9      -0.1230       2.092      FOOD(3)
[o]    10        2.917       1.986      FOOD(4)
[o]    11      0.01220       3.171      CAT(2).TRAP(2)
[o]    12       -2.165       3.072      CAT(2).TRAP(3)
[o]    13        0.000     aliased      CAT(2).TYPE(2)
[o]    14        0.000     aliased      CAT(2).TYPE(3)
[o]    15       -1.124       2.458      TRAP(2).TYPE(2)
[o]    16        0.000     aliased      TRAP(2).TYPE(3)
[o]    17        0.000     aliased      TRAP(3).TYPE(2)
[o]    18        0.000     aliased      TRAP(3).TYPE(3)
[o]    19        0.000     aliased      TRAP(2).FOOD(2)
[o]    20        3.783       2.771      TRAP(2).FOOD(3)
[o]    21        0.000     aliased      TRAP(2).FOOD(4)
[o]    22        0.000     aliased      TRAP(3).FOOD(2)
[o]    23        1.749       2.495      TRAP(3).FOOD(3)
[o]    24       -3.728       2.280      TRAP(3).FOOD(4)
[o]    25        0.000     aliased      TYPE(2).FOOD(2)
[o]    26        0.000     aliased      TYPE(2).FOOD(3)
[o]    27        0.000     aliased      TYPE(2).FOOD(4)
[o]    28        0.000     aliased      TYPE(3).FOOD(2)
[o]    29        0.000     aliased      TYPE(3).FOOD(3)
[o]    30        0.000     aliased      TYPE(3).FOOD(4)
[o]     scale parameter taken as  2.559
[o]
[i] ? $stop$
```

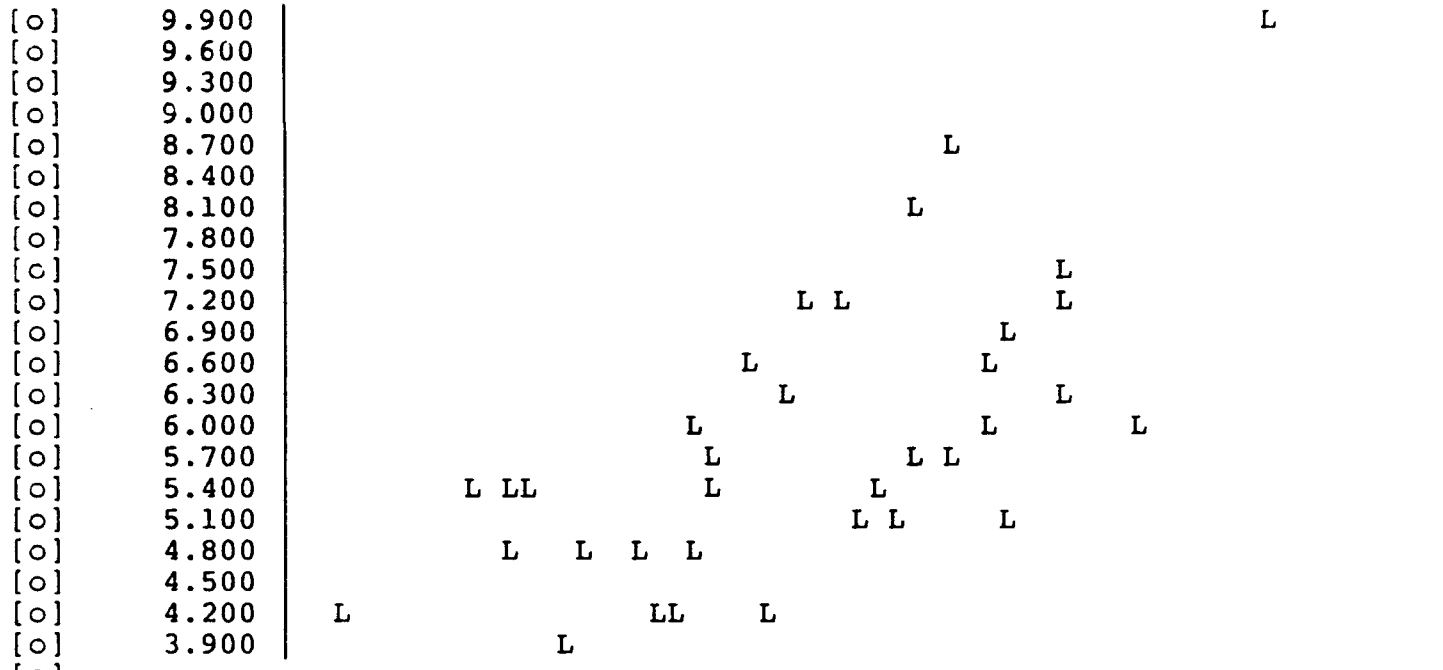
APPENDIX 11

LINEAR REGRESSION/ANCOVA

DER F 1 UNITS OF CONCENTRATION

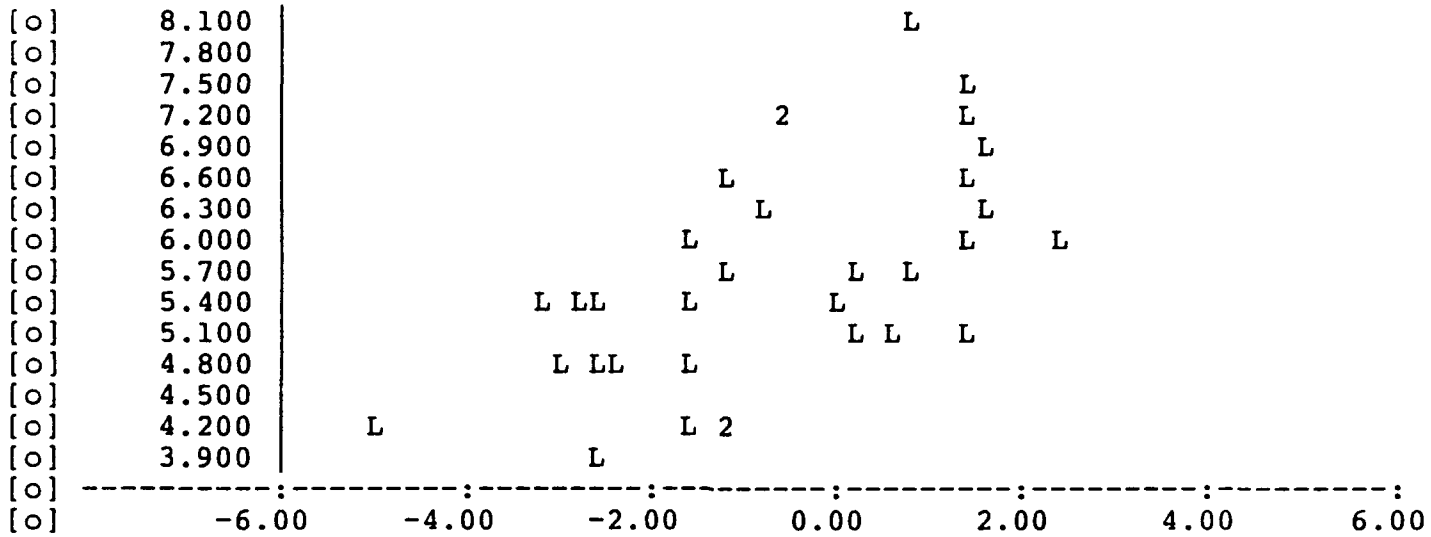
```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vacmite.doc
[i] $subfile a:vac2.doc
[i] $units 35$
[i] !This is a data set of all vacuum samples with detectable Der f 1.
[i] !
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/su· ace. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328       767   97    8      115.1  3    3       1    1
[i] 2  0.245       1156  57    8     60      1    3        1  1
[i] 3  0.227       118   997   7     19     3     3       1    1
[i] 4  0.227       116   132   7     52.7   1     2       1    1
[i] 5  0.621       60   563    5    37.5    2     2       1    2
[i] 6  0.063       247   25    5    47      1     2       1    2
[i]
[i]
[i] 9  0.135   54  2323180     6    17.1    2     3       2    3
[i] 10  0.034  70    264397    10   33.8    1    1        2    3
[i] 11  0.696    318   3323    8.5  23.125   2   3         1   4
[i] 12  0.099    222     2281  7.5  14.6    1    3         1   4
[i] 13  0.247   1167    202    7    76.7     3    3       1   1
[i] 14   0.338  168    97    4.5    9.5     3     1       1   1
[i] 15  0.621   175    228    5     12.75   1    3        1   1
[i]
[i]
[i] 18  0.322   373   25       5   6.4     2   3          1   4
[i] 19  0.087  836  8777972  4     4.3     2    3         2   3
[i] 20  0.024  5718  1830677   5    9.9    1  2           2   3
[i] 21  0.068  301   613       5    13    2   3           1   4
[i] 22  1.302   513   229     7     19.4   1   3          1   4
[i] 23   0.393  208   124     7      12.8   1  3          1   3
[i] 24   0.020  205   25      4.5    20.25  3  1          1   3
[i] 25  0.219   20886  57   8     22.3    1   3          1   3
[i] 26  0.034   3183   25   4    11.9   1    2           1   3
[i] 27  0.038    201   25   4    26.2   3     3          1   1
[i] 28  0.949   62    1350  7.5  23.8   2   2            1   2
[i] 29   0.145   115   25   9    19.0  3   3             1   1
[i] 30  0.148    371    152  7    38.4   3   3           1   1
[i] 32  0.152  59   3134314  4    8.2    2   3           2   3
[i]
[i]
[i] 35  0.036  548   25      7     6.4   2  3            1   4
[i] 36  0.992   190   305   5    9.0    1  3             1   1
[i] 37  0.040   125   514   6    18.1   3   1            1   1
[i] 39  0.180   976   25    5     7.8    3   1           1   4
[i] 41  0.3138  1233  1051  9   11.3    2   3           1   4
[i] 42  0.2433   1657  461  8   11.7   1    3           1   4
[i] 44  0.4155  292   298   6   8.9   2    3            1   4
[i] 45  1.3827   454    25  6   10.3  1   3             1   4
```

```
[i]
[i] $finish$
[i] ? $calc mtot=mngg*dtot$calc msf=mtot/area$calc ta=time*area$
[i] ? $calc mta=mtot/ta$calc lmngg=%log mngg$calc lmsf=%log msf$
[i] ? $calc lmta=%log mta$calc ldtot=%log dtot$
[i] ? $plot mtot dtot$
[o]     5000. |
[o]     4750. |
[o]     4500. |       M
[o]     4250. |
[o]     4000. |
[o]     3750. |
[o]     3500. |
[o]     3250. |
[o]     3000. |
[o]     2750. |
[o]     2500. |
[o]     2250. |
[o]     2000. |
[o]     1750. |
[o]     1500. |
[o]     1250. |
[o]     1000. |
[o]      750. |                                          M  M
[o]      500. |         M M
[o]      250. |M    M 2  M           M          M
[o]        0. |622 4  2  2 MM      2          M
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         0.000     0.300     0.600     0.900     1.200     1.500     1.800
[i] ? !This is a plot of total Der f 1 compared to total sieved dust from th
[i] ? !same filter.
[i] ? $plot mngg msf$
[o]    24000. |
[o]    22800. |
[o]    21600. |
[o]    20400. |                                    M
[o]    19200. |
[o]    18000. |
[o]    16800. |
[o]    15600. |
[o]    14400. |
[o]    13200. |
[o]    12000. |
[o]    10800. |
[o]     9600. |
[o]     8400. |
[o]     7200. |
[o]     6000. |  M
[o]     4800. |
[o]     3600. | M
[o]     2400. |
[o]     1200. M2 M M 2
[o]        0. 932M2  M    M
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]           0.0       50.0      100.0     150.0     200.0     250.0     300.0
[i] ? !This is a plot of Der f 1 in ng/g vs ng/sf.
[i] ?
[i] ? $Plot lmngg lmsf$
```




```
? !This is a plot of the lns of Der f 1 in ng/g vs ng/sf.
?
? $Plot mngg mta$
```


```
? !This is a plot of Der f 1 in ng/g vs ng/sf*min.
?
? $plot lmngg lmta$
```




```
? !This is a plot of the lns of Der f 1 in ng/g vs ng/sf*min.
?
? $yvar lmta$error n$link i$fac type 3$fac food 4$fac trap 3$fac cat 2$f
deviance = 118.66
    d.f. =  34

? $dis e$fit +lmngg$dis e$
          estimate        s.e.     parameter
    1     -0.5189      0.3158     1
    scale parameter taken as  3.490

deviance = 66.026 (change =  -52.64)
    d.f. = 33     (change =   -1   )

          estimate        s.e.     parameter
    1       -5.930       1.082     1
    2       0.9226      0.1799     LMNG
    scale parameter taken as  2.001

? !R = 0.666.  p<0.05.   The y intercept is not zero.
? $calc res=lmta-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[-3.0,-2.0) 1  S
[-2.0,-1.0) 5  SSSSS
[-1.0, 0.0) 13 SSSSSSSSSSSSS
[ 0.0, 1.0) 9  SSSSSSSSS
[ 1.0, 2.0] 7  SSSSSSS
? !The residuals are fairly bell shaped.
? !If the grand mean is subtracted to force through zero:
? $fit -%gm$dis e$
deviance = 126.15 (change =  +60.13)
    d.f. =  34    (change =   +1   )

          estimate        s.e.     parameter
    1    -0.03909     0.05415     LMNG
    scale parameter taken as  3.710

? !The slope is no longer significant if forced through zero.
? !If not forced through zero, the Der f 1 in ng/g is loosely correlated
? !with ng/sf*min, with r=0.67, but it is statistically significant at p
? $fit +food$dis e$fit +trap$dis e$fit +type$dis e$fit +cat$dis e$
deviance = 55.076 (change =  -71.08)
```

```
[o]     d.f. = 30     (change =   -4   )
[o]
[o]           estimate        s.e.     parameter
[o]      1      0.8589      0.1865     LMNG
[o]      2      -5.939       1.107     FOOD(1)
[o]      3      -5.745       1.158     FOOD(2)
[o]      4      -5.998       1.252     FOOD(3)
[o]      5      -4.726       1.232     FOOD(4)
[o]     scale parameter taken as  1.836
[o]
[o] deviance = 50.839 (change =  -4.237)
[o]     d.f. = 28     (change =  -2    )
[o]
[o]           estimate        s.e.     parameter
[o]      1      0.8445      0.1978     LMNG
[o]      2      -6.590       1.183     FOOD(1)
[o]      3      -5.887       1.373     FOOD(2)
[o]      4      -6.483       1.286     FOOD(3)
[o]      5      -5.502       1.336     FOOD(4)
[o]      6      0.2083       1.063     TRAP(2)
[o]      7      0.9522      0.6878     TRAP(3)
[o]     scale parameter taken as  1.816
[o]
[o] deviance = 46.760 (change =  -4.078)
[o]     d.f. = 26     (change =  -2    )
[o]
[o]           estimate        s.e.     parameter
[o]      1      0.9406      0.2173     LMNG
[o]      2      -5.713       1.394     FOOD(1)
[o]      3      -5.512       1.611     FOOD(2)
[o]      4      -6.409       1.418     FOOD(3)
[o]      5      -5.471       1.492     FOOD(4)
[o]      6     -0.8205       1.262     TRAP(2)
[o]      7      0.1791      0.8637     TRAP(3)
[o]      8      0.3213      0.6700     TYPE(2)
[o]      9      -1.117      0.7898     TYPE(3)
[o]     scale parameter taken as  1.798
[o]
[o] deviance = 46.040 (change = -0.7206)
[o]     d.f. = 25     (change = -1     )
[o]
[o]           estimate        s.e.     parameter
[o]      1      0.9109      0.2249     LMNG
[o]      2      -5.468       1.464     FOOD(1)
[o]      3      -5.451       1.633     FOOD(2)
[o]      4      -5.875       1.670     FOOD(3)
[o]      5      -5.312       1.531     FOOD(4)
[o]      6     -0.8314       1.277     TRAP(2)
[o]      7      0.1377      0.8765     TRAP(3)
[o]      8      0.4496      0.7083     TYPE(2)
[o]      9      -1.190      0.8076     TYPE(3)
[o]     10     -0.6437       1.029     CAT(2)
[o]     scale parameter taken as  1.842
[o]
[i] ? !Putting in the factors of food, trapping, and type make the slope
[i] ? !statistically significant again, with the grand mean subtracted out.
[i] ?
[i] ? $Yvar lmsf$error n$link i$fac type 3$fac food 4$fac trap 3$
```

```
[w] -- model changed



[i] ? $fit %gm$dis e$fit +lmngg$dis e$
[o] deviance = 117.48
[o]     d.f. =  34
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.293      0.3142     1
[o]     scale parameter taken as  3.455
[o]
[o] deviance = 63.333 (change =  -54.15)
[o]     d.f. = 33     (change =   -1   )
[o]
[o]          estimate        s.e.     parameter
[o]     1      -4.196       1.059     1
[o]     2      0.9358      0.1762     LMNG
[o]     scale parameter taken as  1.919
[o]
[i] ? !There is a statistically significant correlation between the ln of De
[i] ? !in ng/g and ng/sf with R=0.679.  There is a y intercept, however.
[i] ? $calc res=lmngg-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [3.2,3.3) 11 SSSSSSSSSSS
[o] [3.3,3.3) 14 SSSSSSSSSSSSSS
[o] [3.3,3.4) 7  SSSSSSS
[o] [3.4,3.5) 2  SS
[o] [3.5,3.5] 1  S
[i] ? !Residuals are a little skewed.
[i] ? $fit -%gm$dis e$fit +food$dis e$fit +trap$dis e$fit +type$dis e$
[o] deviance = 93.435 (change =  +30.10)
[o]     d.f. = 34     (change =   +1   )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.2554     0.04660     LMNG
[o]     scale parameter taken as  2.748
[o]
[o] deviance = 50.323 (change =  -43.11)
[o]     d.f. = 30     (change =   -4   )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.8726      0.1783     LMNG
[o]     2      -4.178       1.058     FOOD(1)
[o]     3      -4.063       1.107     FOOD(2)
[o]     4      -4.373       1.197     FOOD(3)
[o]     5      -2.926       1.178     FOOD(4)
[o]     scale parameter taken as  1.677
[o]
[o] deviance = 45.050 (change =  -5.273)
[o]     d.f. = 28     (change =  -2    )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.8644      0.1862     LMNG
[o]     2      -4.911       1.113     FOOD(1)
[o]     3      -4.134       1.293     FOOD(2)
```

```
[o]      4       -4.916        1.210      FOOD(3)
[o]      5       -3.808        1.258      FOOD(4)
[o]      6       0.1087        1.000      TRAP(2)
[o]      7        1.026       0.6474      TRAP(3)
[o]      scale parameter taken as  1.609
[o]
[o] deviance = 40.408 (change =  -4.642)
[o]      d.f. = 26     (change =  -2    )
[o]
[o]           estimate         s.e.      parameter
[o]      1      0.9497       0.2020      LMNG
[o]      2      -3.873        1.295      FOOD(1)
[o]      3      -3.541        1.497      FOOD(2)
[o]      4      -4.691        1.319      FOOD(3)
[o]      5      -3.612        1.387      FOOD(4)
[o]      6     -0.9981        1.173      TRAP(2)
[o]      7      0.2390       0.8029      TRAP(3)
[o]      8      0.1848       0.6228      TYPE(2)
[o]      9      -1.244       0.7342      TYPE(3)
[o]      scale parameter taken as  1.554
[o]
[i] ? $calc res=lmngg-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [2.5,3.0) 9  SSSSSSSSS
[o] [3.0,3.5) 4  SSSS
[o] [3.5,4.0) 9  SSSSSSSSS
[o] [4.0,4.5) 10 SSSSSSSSSS
[o] [4.5,5.0] 3  SSS
[i] ? !Bimodal??? This is with food and trapping and type furniture added as
[i] ? !ficant.
[i] ?
[i] ?
[i] ?
[i] ?
[i] ?
[i] ?

[i] ?
[i] ? $stop$
```

APPENDIX 12

LINEAR REGRESSION/ANCOVA

FEL D 1 UNITS OF CONCENTRATION

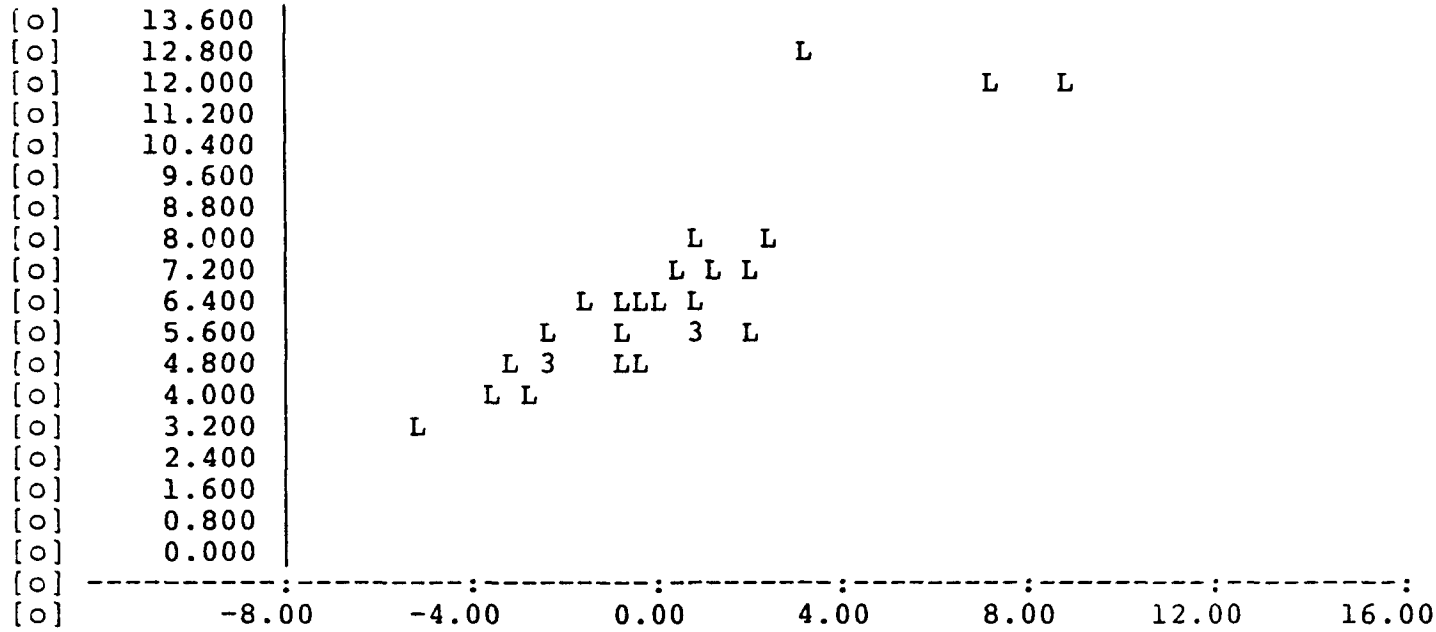
```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vaccat.doc
[i] $subfile a:vac2.doc
[i] $units 32$
[i] !This is a data set of all vacuum samples which had detectable Fel d 1.
[i] !
[i] !dtot = the total mass of dust removed from the filter.  mngg= mass of
[i] !Der f I mite allergen in nanograms per gram of total dust.  cngg= mass
[i] !of Fel d I cat allergen in nanograms per gram of total dust.  time=
[i] !sample collection time in minutes.  area= the area of surface vacuumed
[i] !in square feet.  type= tpe of surface; 1 is carpet 2 is sofa or chair
[i] !3 is mattress or pillow.  trap = a number to scale from 1 to 3 to indic
[i] !the thickness/depth combination of the source/surface. no = the sample
[i] $data no dtot  mngg  cngg  time  area  type  trap cat food$
[i] $read
[i] 1  0.328       767   97    8      115.1  3    3       1    1
[i] 2  0.245       1156  57    8      60      1    3        1   1
[i] 3  0.227       118   997   7      19     3    3       1    1
[i] 4  0.227       116   132   7      52.7   1    2       1    1
[i] 5  0.621       60    563   5     37.5    2    2       1    2
[i] 6  0.063       247   25    5     47      1    2       1    2
[i] 7  0.159       25    157   8     37.5    3    3       1    1
[i] 8  0.179      25     557   6     40      1    2       1    1
[i] 9  0.135   54  2323180     6     17.1    2    3       2    3
[i] 10  0.034  70    264397    10    33.8    1    1       2    3
[i] 11  0.696    318   3323    8.5  23.125   2   3        1    4
[i] 12  0.099    222     2281  7.5  14.6    1    3        1    4
[i] 13  0.247   1167    202    7    76.7     3    3       1    1
[i] 14   0.338  168    97    4.5    9.5     3    1       1    1
[i] 15  0.621   175    228    5     12.75   1    3       1    1
[i]
[i] 17   0.083  25   207     4     8.7      1    3       1    4
[i]
[i] 19  0.087  836  8777972  4     4.3     2    3       2    3
[i] 20  0.024  5718  1830677   5    9.9    1  2          2    3
[i] 21  0.068  301   613       5    13    2   3          1    4
[i] 22  1.302   513   229     7     19.4   1   3         1    4
[i] 23   0.393  208   124     7      12.8   1  3         1    3
[i]
[i] 25  0.219   20886  57   8     22.3    1   3         1    3
[i]
[i]
[i] 28  0.949   62    1350  7.5  23.8   2   2           1    2
[i]
[i] 30  0.148    371    152  7    38.4   3   3          1    1
[i] 32  0.152  59   3134314  4    8.2    2   3          2    3
[i] 33  1.029  25  147843    4     6.0   1  2           2    3
[i] 34  0.372  25  114042      4.5   6.1  1  2          2    3
[i]
[i] 36  0.992   190   305   5    9.0    1  3            1    1
[i] 37  0.040   125   514   6    18.1   3   1           1    1
[i]
[i] 41  0.3138  1233  1051  9   11.3    2   3          1    4
[i] 42  0.2433   1657  461  8   11.7   1    3          1    4
[i] 44  0.4155  292   298   6   8.9   2    3             1  4
[i]
```

```
[i]
[i] $finish$
[i] ? $calc ctot=cngg*dtot$calc ta=time*area$calc cta=ctot/ta$
[i] ? $calc csf=ctot/area$calc lcngg=%log cngg$calc lcta=%log cta$
[i] ? $calc lcsf=%log csf$calc ldtot=%log dtot$
[i] ? $plot ctot dtot$
[o]   800000. |
[o]   760000. |  C
[o]   720000. |
[o]   680000. |
[o]   640000. |
[o]   600000. |
[o]   560000. |
[o]   520000. |
[o]   480000. |    C
[o]   440000. |
[o]   400000. |
[o]   360000. |
[o]   320000. |    C
[o]   280000. |
[o]   240000. |
[o]   200000. |
[o]   160000. |                                C
[o]   120000. |
[o]    80000. |
[o]    40000. |C          C
[o]        0. |222 2CC5 C2 CC      2 C        CC         C
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         0.000     0.300     0.600     0.900     1.200     1.500     1.800
[i] ? !This is a plot of total Fel d 1 vs total sieved dust off filter.
[i] ?
[i] ? $plot lcngg ldtot$
[o]    16.000 |                    L
[o]    15.200 |                       L
[o]    14.400 |  L                    L
[o]    13.600 |
[o]    12.800 |       L
[o]    12.000 |                                    L           L
[o]    11.200 |
[o]    10.400 |
[o]     9.600 |
[o]     8.800 |
[o]     8.000 |                    L                       L
[o]     7.200 |                                 L    L           L
[o]     6.400 |         L     L            L   L           L
[o]     5.600 |               L                L     L    L     L  L
[o]     4.800 |                         LL   L    2 L
[o]     4.000 |                              LL
[o]     3.200 |             L
[o]     2.400 |
[o]     1.600 |
[o]     0.800 |
[o]     0.000 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]        -4.000    -3.200    -2.400    -1.600    -0.800     0.000     0.800
[i] ? !This is a plot of the ln of Fel d 1 vs ln total sieved dust off filte
[i] ?
[i] ? $Plot cngg csf$
```

```
[o]  1.00e+07 |
[o]  9.50e+06 |
[o]  9.00e+06 |                                                    C
[o]  8.50e+06 |
[o]  8.00e+06 |
[o]  7.50e+06 |
[o]  7.00e+06 |
[o]  6.50e+06 |
[o]  6.00e+06 |
[o]  5.50e+06 |
[o]  5.00e+06 |
[o]  4.50e+06 |
[o]  4.00e+06 |
[o]  3.50e+06 |
[o]  3.00e+06 |                C
[o]  2.50e+06 |     C
[o]  2.00e+06 |C
[o]  1.50e+06 |
[o]  1.00e+06 |
[o]  5.00e+05 C
[o]  0.00e+00 9 C   C
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]            0.    40000.    80000.   120000.   160000.   200000.   240000
[i] ? !This is Fel d 1 in ng/g vs ng/sf.
[i] ?
[i] ? $plot lcngg lcsf$
[o]    16.000 |                                              L
[o]    15.200 |                                           L
[o]    14.400 |                                     L   L
[o]    13.600 |
[o]    12.800 |                          L
[o]    12.000 |                                    L  L
[o]    11.200 |
[o]    10.400 |
[o]     9.600 |
[o]     8.800 |
[o]     8.000 |                   L    L
[o]     7.200 |                 L L L
[o]     6.400 |           L LL  2
[o]     5.600 |         L  L   L2 L
[o]     4.800 |       L 3   2
[o]     4.000 |      L  L
[o]     3.200 |  L
[o]     2.400 |
[o]     1.600 |
[o]     0.800 |
[o]     0.000 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         -4.00      0.00      4.00      8.00     12.00     16.00     20.00
[i] ? !This is a plot of the Fel d 1 ln of ng/g vs ln of ng/sf.
[i] ?
[i] ? $yvar lcngg$fac cat 2$fac type 3$fac trap 3$error n$link i$fit %gm$dis
[o] deviance = 406.51
[o]     d.f. =  31
[o]
[o]           estimate        s.e.     parameter
[o]     1        7.424      0.6401     1
[o]     scale parameter taken as  13.11
```

```
[o]
[i] ? $fit +lcsf$dis e$
[o] deviance = 44.965 (change =  -361.5)
[o]     d.f. = 30     (change =    -1  )
[o]
[o]           estimate        s.e.     parameter
[o]     1        4.851      0.2726     1
[o]     2       0.8614     0.05546     LCSF
[o]     scale parameter taken as  1.499
[o]
[i] ? !Slope is significant p,0.05 for ln of ng/g vs ln of ng/sf.  R= 0.943.
[i] ? !These two measurements are highly correlated.  There is a y-intercept
[i] ? !If subtract the grand mean and add factors:
[i] ? $fit +cat$dis e$
[o] deviance = 23.077 (change =  -21.89)
[o]     d.f. = 29     (change =   -1   )
[o]
[o]           estimate        s.e.     parameter
[o]     1        5.081      0.2034     1
[o]     2       0.4868     0.08205     LCSF
[o]     3        4.062      0.7746     CAT(2)
[o]     scale parameter taken as  0.7958
[o]
[i] ? !Slope is still significant when accounting for presence or absence of
[i] ? $Fit -%gm$dis e$
[o] deviance = 23.077 (change =  0.)
[o]     d.f. = 29     (change =  0 )
[o]
[o]           estimate        s.e.     parameter
[o]     1       0.4868     0.08205     LCSF
[o]     2        5.081      0.2034     CAT(1)
[o]     3        9.143      0.8422     CAT(2)
[o]     scale parameter taken as  0.7958
[o]
[i] ? !Still signficant if grand mean removed.
[i] ? $calc res=lcngg-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [-3.0,-2.0) 2  SS
[o] [-2.0,-1.0) 4  SSSS
[o] [-1.0, 0.0) 7  SSSSSSS
[o] [ 0.0, 1.0) 15 SSSSSSSSSSSSSSS
[o] [ 1.0, 2.0] 4  SSSS
[i] ? !residuals are somewhat bell-shaped.
[i] ? $fit +trap$dis e$fit +type$dis e$fit +type.trap$dis e$
[o] deviance = 22.474 (change = -0.6036)
[o]     d.f. = 27     (change = -2     )
[o]
[o]           estimate        s.e.     parameter
[o]     1       0.4832     0.08914     LCSF
[o]     2        5.264      0.5457     CAT(1)
[o]     3        9.416      0.9281     CAT(2)
[o]     4      -0.4249      0.6263     TRAP(2)
[o]     5      -0.1303      0.5978     TRAP(3)
[o]     scale parameter taken as  0.8324
[o]
[o] deviance = 18.674 (change =  -3.800)
[o]     d.f. = 25     (change =  -2    )
[o]
[o]           estimate        s.e.     parameter
```

```
[o]      1       0.3864       0.1008      LCSF
[o]      2        4.989       0.6110      CAT(1)
[o]      3        9.847        1.010      CAT(2)
[o]      4      -0.2782       0.6491      TRAP(2)
[o]      5    -0.09371       0.5902      TRAP(3)
[o]      6       0.9347       0.4269      TYPE(2)
[o]      7       0.3965       0.4481      TYPE(3)
[o]     scale parameter taken as  0.7470
[o]
[o] deviance = 17.927 (change = -0.7474)
[o]     d.f. = 23     (change = -2     )
[o]
[o]           estimate         s.e.      parameter
[o]      1       0.4414       0.1174      LCSF
[o]      2        5.851        1.088      CAT(1)
[o]      3        10.02        1.100      CAT(2)
[o]      4      -0.9943        1.045      TRAP(2)
[o]      5       -1.110        1.202      TRAP(3)
[o]      6        1.054       0.5063      TYPE(2)
[o]      7      -0.7442        1.282      TYPE(3)
[o]      8      -0.5129        1.008      TRAP(2).TYPE(2)
[o]      9        0.000      aliased      TRAP(2).TYPE(3)
[o]     10        0.000      aliased      TRAP(3).TYPE(2)
[o]     11        1.392        1.448      TRAP(3).TYPE(3)
[o]     scale parameter taken as  0.7794
[o]
[i] ? !Still significant slope, but the only factor that matters is cat pres
[i] ?
[i] ? $plot cngg cta$
[o]  1.00e+07 |
[o]  9.50e+06 |
[o]  9.00e+06 |                                                    C
[o]  8.50e+06 |
[o]  8.00e+06 |
[o]  7.50e+06 |
[o]  7.00e+06 |
[o]  6.50e+06 |
[o]  6.00e+06 |
[o]  5.50e+06 |
[o]  5.00e+06 |
[o]  4.50e+06 |
[o]  4.00e+06 |
[o]  3.50e+06 |
[o]  3.00e+06 |                C
[o]  2.50e+06 |   C
[o]  2.00e+06 | C
[o]  1.50e+06 |
[o]  1.00e+06 |
[o]  5.00e+05 C
[o]  0.00e+00 9 C   C
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]           0.    10000.    20000.    30000.    40000.    50000.    60000
[i] ? !Fel d 1 in ng/g vs ng/sf*min.
[i] ?
[i] ? $plot lcngg lcta$
[o]    16.000 |                                                        L
[o]    15.200 |                                                   L
[o]    14.400 |                                              L  L
```




```
[i] ?
[i] ? !Ln of ng/g vs ln of ng/sf*min, Fel d 1.
[i] ?
[i] ? $yvar lcta$fac cat 2$fac trap 3$fac type 3$error n$link i$fit %gm$dis
[w] -- model changed
[o] deviance = 517.34
[o]     d.f. =  31
[o]
[o]           estimate        s.e.     parameter
[o]     1        1.172      0.7222     1
[o]     scale parameter taken as  16.69
[o]
[i] ? $fit +lcngg$dis e$calc res=lcngg-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] deviance = 62.233 (change =  -455.1)
[o]     d.f. = 30     (change =    -1  )
[o]
[o]           estimate        s.e.     parameter
[o]     1       -6.684      0.5883     1
[o]     2        1.058     0.07144     LCNG
[o]     scale parameter taken as  2.074
[o]
[o] [4.0,4.1) 4  SSSS
[o] [4.1,4.2) 3  SSS
[o] [4.2,4.3) 1  S
[o] [4.3,4.4) 17 SSSSSSSSSSSSSSSS
[o] [4.4,4.6] 7  SSSSSSS
[i] ? !Slope is significant p<<0.05.  R = 0.938.
[i] ? !These two measures are highly correlated - ng/g vs ng/sf*min.
[i] ? !Residual is sort of bimodal.
[i] ? !There is a y-intercept.
[i] ? $fit +cat$dis e$
[o] deviance = 62.030 (change = -0.2023)
```

```
[o]     d.f. = 29     (change = -1     )
[o]
[o]          estimate        s.e.     parameter
[o]     1      -7.002       1.195     1
[o]     2       1.117      0.2046     LCNG
[o]     3     -0.5426       1.764     CAT(2)
[o]     scale parameter taken as  2.139
[o]
[i] ? $calc res=lcngg-%fv$calc sre=res/%sqrt(%sc)$hist sre$
[o] [3.8,4.0) 3  SSS
[o] [4.0,4.1) 2  SS
[o] [4.1,4.3) 12 SSSSSSSSSSS
[o] [4.3,4.4) 12 SSSSSSSSSSS
[o] [4.4,4.6] 3  SSS
[i] ? $fit -%gm$dis e$fit +trap$dis e$fit +type$dis e$
[o] deviance = 62.030 (change =  0.)
[o]     d.f. = 29     (change =  0 )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.117      0.2046     LCNG
[o]     2      -7.002       1.195     CAT(1)
[o]     3      -7.545       2.862     CAT(2)
[o]     scale parameter taken as  2.139
[o]
[o] deviance = 58.324 (change =  -3.707)
[o]     d.f. = 27     (change =  -2    )
[o]
[o]          estimate        s.e.     parameter
[o]     1       1.076      0.2146     LCNG
[o]     2      -7.861       1.386     CAT(1)
[o]     3      -7.997       3.007     CAT(2)
[o]     4       1.181      0.9958     TRAP(2)
[o]     5       1.188      0.9346     TRAP(3)
[o]     scale parameter taken as  2.160
[o]
[o] deviance = 54.356 (change =  -3.967)
[o]     d.f. = 25     (change =  -2    )
[o]
[o]          estimate        s.e.     parameter
[o]     1      0.9436      0.2708     LCNG
[o]     2      -6.580       1.717     CAT(1)
[o]     3      -5.944       3.654     CAT(2)
[o]     4      0.5789       1.108     TRAP(2)
[o]     5      0.7512      0.9959     TRAP(3)
[o]     6      0.4871      0.7897     TYPE(2)
[o]     7     -0.7660      0.7573     TYPE(3)
[o]     scale parameter taken as  2.174
[o]
[i] ? !Slope is still significant when grand mean is subtracted. Presence of
[i] ? !cat is important.
[i] ? $stop$
```

APPENDIX 13

LINEAR REGRESSION/ANCOVA

FEL D 1 AIR VS SURFACE SAMPLES

```
[o] GLIM 3.77 update 1 (copyright)1985 Royal Statistical Society, London
[o]
[i] ? $input 12$
[i] File name? a:vac4.doc
[i] $subfile vac3.doc
[i] !
[i] $echo$
[i] $units 7$
[i] $data Ano  cat   cconc    vol    act   vno  mngg   cngg  area  time  dtot
[i] $read
[i]       614 2 0.101 21682.5   2    30   371    152   38.4   7   0.148
[i]
[i]
[i]
[i]
[i]
[i]       619  2     0.04    21254.75  1  9 54 2323180 17.1   6          0.1
[i]
[i]
[i]       613 2      61.441   472      4     9    54  2323180 17.1   6     0.1
[i]       612  1      0.029 21269.5    3     9    54  2323180 17.1   6     0.1
[i]       624  2     0.054  20487.75   3    34    25  114042   6.1   4.5   0.3
[i]
[i]
[i]       6292 2      0.019 20945      3    19   836   8777972 4.3   4     0.0
[i]       6291 1     0.019  21240      3    44   292       298  8.9  6     0.4
[i]
[i] $echo$
[i] !This is a set of paired vacuum and air samples.  Ano is the air
[i] !sample number.  mconc is the air sample Der f 1 concentration.
[i] !cconc is cat air concentration.  Both in ng/m3.  Vno is vacuum
[i] !sample number. Activity is 1 if none 2 if low 3 if moderate
[i] ! 4 if high.  Mngg is vacuum concentration for Der f 1.  Cngg
[i] !is vacuum conc for cat.  Area is vacuum sample area.  Time is
[i] !vacuum sample time. Vol is air sample volume.
[i] $echo$
[i] $finish$
[i] ? $plot cngg cconc$
[o]  1.00e+07 |
[o]  9.50e+06 |
[o]  9.00e+06 C
[o]  8.50e+06 |
[o]  8.00e+06 |
[o]  7.50e+06 |
[o]  7.00e+06 |
[o]  6.50e+06 |
[o]  6.00e+06 |
[o]  5.50e+06 |
[o]  5.00e+06 |
[o]  4.50e+06 |
[o]  4.00e+06 |
[o]  3.50e+06 |
[o]  3.00e+06 |
[o]  2.50e+06 2                                        C
[o]  2.00e+06 |
[o]  1.50e+06 |
[o]  1.00e+06 |
[o]  5.00e+05 |
```

```
[o]  0.00e+00 3
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]           0.0      16.0      32.0      48.0      64.0      80.0      96.0
[i] ? $yvar cngg$error n$link i$fac cat 2$fac act 4$fit %gm$dis e$fit +cconc
[o] deviance = 5.731e+13
[o]     d.f. =     6
[o]
[o]           estimate        s.e.     parameter
[o]     1     2266001.    1168169.     1
[o]     scale parameter taken as  9.552e+12
[o]
[o] deviance = 5.731e+13 (change =  -3275751424.)
[o]     d.f. =     5     (change =           -1 )
[o]
[i] ? $dis e$fit +act$dis e$fit +cat$dis e$
[o]           estimate        s.e.     parameter
[o]     1     2257127.    1383142.     1
[o]     2        1007.      59560.     CCON
[o]     scale parameter taken as  1.146e+13
[o]
[o] deviance = 5.102e+13 (change = -6.295e+12)
[o]     d.f. =     3     (change =     -2    )
[o]
[o]           estimate        s.e.     parameter
[o]     1     2324794.    4126445.     1
[o]     2       -52.49      94980.     CCON
[o]     3    -2324636.    5828980.     ACT(2)
[o]     4      479081.    4611087.     ACT(3)
[o]     5        0.000     aliased     ACT(4)
[o]     scale parameter taken as  1.701e+13
[o]
[o] deviance = 4.023e+13 (change = -1.079e+13)
[o]     d.f. =     2     (change =     -1    )
[o]
[o]           estimate        s.e.     parameter
[o]     1     -958806.    6344111.     1
[o]     2       -74.27     103299.     CCON
[o]     3    -2325304.    6339542.     ACT(2)
[o]     4     2120547.    5493140.     ACT(3)
[o]     5        0.000     aliased     ACT(4)
[o]     6     3284269.    4484960.     CAT(2)
[o]     scale parameter taken as  2.011e+13
[o]
[i] ? !no relationship
[i] ? $calc lcconc=%log cconc$calc lcngg=%log cngg$
[i] ? $plot lcconc lcngg$
[o]     5.000 |
[o]     4.500 |
[o]     4.000 |                                          L
[o]     3.500 |
[o]     3.000 |
[o]     2.500 |
[o]     2.000 |
[o]     1.500 |
[o]     1.000 |
[o]     0.500 |
[o]     0.000 |
[o]    -0.500 |
```

```
[o]    -1.000 |
[o]    -1.500 |
[o]    -2.000 |
[o]    -2.500 L
[o]    -3.000 |                              L           L
[o]    -3.500 |                                          L
[o]    -4.000 |   L                                           L
[o]    -4.500 |
[o]    -5.000 |
[o]  ----------:---------:---------:---------:---------:---------:---------:
[o]          5.00      7.50     10.00     12.50     15.00     17.50     20.00
[i] ? $yvar lcconc$error n$link i$fac cat 2$fac act 4$fit %gm$dis e$fit +lcn
[w] -- model changed
[o] deviance = 49.476
[o]     d.f. =  6
[o]
[o]           estimate        s.e.     parameter
[o]     1       -2.254       1.085     1
[o]     scale parameter taken as  8.246
[o]
[o] deviance = 47.578 (change =  -1.898)
[o]     d.f. =  5     (change =  -1    )
[o]
[i] ? $dis e$fit +act$dis e$fit +cat$dis e$
[o]           estimate        s.e.     parameter
[o]     1       -3.702       3.445     1
[o]     2       0.1231      0.2757     LCNG
[o]     scale parameter taken as  9.516
[o]
[o] deviance = 0.72244 (change =  -46.86)
[o]     d.f. = 2       (change =   -3   )
[o]
[o]           estimate        s.e.     parameter
[o]     1       -3.396       1.264     1
[o]     2      0.01205     0.07583     LCNG
[o]     3        1.042       1.121     ACT(2)
[o]     4      -0.3455      0.7016     ACT(3)
[o]     5        7.337      0.8500     ACT(4)
[o]     scale parameter taken as  0.3612
[o]
[o] deviance = 0.63212 (change = -0.09032)
[o]     d.f. = 1       (change = -1      )
[o]
[o]           estimate        s.e.     parameter
[o]     1       -3.447       1.677     1
[o]     2    -0.007538      0.1129     LCNG
[o]     3       0.8536       1.564     ACT(2)
[o]     4      -0.2285      0.9784     ACT(3)
[o]     5        7.337       1.124     ACT(4)
[o]     6       0.3383      0.8949     CAT(2)
[o]     scale parameter taken as  0.6321
[o]
[i] ? !no relationship
[i] ? $calc ctot=cngg*dtot$calc csf=ctot/area$calc ta=time*area$
[i] ? $calc cta=ctot/ta$calc lcsf=%log csf$calc lcta=%log cta$
[i] ? $plot csf cconc$
[o]   200000. |
[o]   190000. |
```

```
[o]   180000. C
[o]   170000. |
[o]   160000. |
[o]   150000. |
[o]   140000. |
[o]   130000. |
[o]   120000. |
[o]   110000. |
[o]   100000. |
[o]    90000. |
[o]    80000. |
[o]    70000. |
[o]    60000. |
[o]    50000. |
[o]    40000. |
[o]    30000. |
[o]    20000. 2                                        C
[o]    10000. C
[o]        0. 2
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]           0.0       16.0       32.0       48.0       64.0       80.0       96.0
[i] ? $plot lcsf lcconc$
[o]    13.600 |
[o]    12.800 |
[o]    12.000 L
[o]    11.200 |
[o]    10.400 |
[o]     9.600 | L L                                      L
[o]     8.800 |    L
[o]     8.000 |
[o]     7.200 |
[o]     6.400 |
[o]     5.600 |
[o]     4.800 |
[o]     4.000 |
[o]     3.200 |
[o]     2.400 L
[o]     1.600 |
[o]     0.800 |
[o]     0.000 |
[o]    -0.800 |         L
[o]    -1.600 |
[o]    -2.400 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         -4.00      -2.00       0.00       2.00       4.00       6.00       8.00
[i] ? $yvar lcsf$fac cat 2$fac act 4$error n$link i$fit %gm$dis e$fit +lccon
[w] -- model changed
[o] deviance = 127.21
[o]     d.f. =   6
[o]
[o]           estimate        s.e.     parameter
[o]     1        7.498       1.740     1
[o]     scale parameter taken as  21.20
[o]
[o] deviance = 125.41 (change =  -1.801)
[o]     d.f. =   5    (change =  -1    )
[o]
[i] ? $dis e$fit +cat$dis e$fit +act$dis e$
```

```
[o]          estimate          s.e.      parameter
[o]     1       7.928         2.482      1
[o]     2      0.1908        0.7120      LCCO
[o]     scale parameter taken as  25.08
[o]
[o] deviance = 122.28 (change =  -3.124)
[o]     d.f. =   4    (change =  -1    )
[o]
[o]          estimate          s.e.      parameter
[o]     1       6.581         5.025      1
[o]     2     0.09499        0.8413      LCCO
[o]     3       1.583         4.951      CAT(2)
[o]     scale parameter taken as  30.57
[o]
[o] deviance = 31.008 (change =  -91.28)
[o]     d.f. =  1     (change =   -3   )
[o]
[o]          estimate          s.e.      parameter
[o]     1       4.611         25.89      1
[o]     2     -0.2729         6.988      LCCO
[o]     3       4.327         5.977      CAT(2)
[o]     4      -10.10         10.19      ACT(2)
[o]     5      0.5897         6.994      ACT(3)
[o]     6       2.003         51.87      ACT(4)
[o]     scale parameter taken as  31.01
[o]
[i] ? !nothing is significant
[i] ? $fit -%gm$dis e$
[o] deviance = 31.008 (change =  0.)
[o]     d.f. =  1     (change =  0 )
[o]
[o]          estimate          s.e.      parameter
[o]     1     -0.2729         6.988      LCCO
[o]     2       4.611         25.89      CAT(1)
[o]     3       8.938         23.17      CAT(2)
[o]     4      -10.10         10.19      ACT(2)
[o]     5      0.5897         6.994      ACT(3)
[o]     6       2.003         51.87      ACT(4)
[o]     scale parameter taken as  31.01
[o]
[i] ? $plot lcta lcconc$
[o]    12.000 |
[o]    11.200 |
[o]    10.400 L
[o]     9.600 |
[o]     8.800 |
[o]     8.000 |  L L                                          L
[o]     7.200 |     L
[o]     6.400 |
[o]     5.600 |
[o]     4.800 |
[o]     4.000 |
[o]     3.200 |
[o]     2.400 |
[o]     1.600 |
[o]     0.800 L
[o]     0.000 |
[o]    -0.800 |
```

```
[o]    -1.600 |
[o]    -2.400 |          L
[o]    -3.200 |
[o]    -4.000 |
[o] ----------:---------:---------:---------:---------:---------:---------:
[o]         -4.00     -2.00      0.00      2.00      4.00      6.00      8.00
[i] ? $yvar lcta$fac cat 2$fac act 4$error n$link i$fit %gm$dis e$fit +lccon
[w] -- model changed
[o] deviance = 134.41
[o]     d.f. =   6
[o]
[o]           estimate        s.e.     parameter
[o]     1        5.783       1.789     1
[o]     scale parameter taken as  22.40
[o]
[o] deviance = 132.93 (change =  -1.482)
[o]     d.f. =   5    (change =  -1    )
[o]
[i] ? $dis e$fit +cat$dis e$fit +act$dis e$
[o]           estimate        s.e.     parameter
[o]     1        6.173       2.555     1
[o]     2       0.1731      0.7330     LCCO
[o]     scale parameter taken as  26.59
[o]
[o] deviance = 129.12 (change =  -3.814)
[o]     d.f. =   4    (change =  -1    )
[o]
[o]           estimate        s.e.     parameter
[o]     1        4.685       5.163     1
[o]     2      0.06718      0.8645     LCCO
[o]     3        1.749       5.087     CAT(2)
[o]     scale parameter taken as  32.28
[o]
[o] deviance = 31.357 (change =  -97.76)
[o]     d.f. =  1     (change =   -3   )
[o]
[o]           estimate        s.e.     parameter
[o]     1        2.131       26.04     1
[o]     2      -0.3698       7.027     LCCO
[o]     3        4.704       6.011     CAT(2)
[o]     4       -10.16       10.25     ACT(2)
[o]     5       0.9148       7.034     ACT(3)
[o]     6        2.713       52.16     ACT(4)
[o]     scale parameter taken as  31.36
[o]
[i] ? $fit -%gm$dis e$
[o] deviance = 31.357 (change =  0.)
[o]     d.f. =  1     (change =  0 )
[o]
[o]           estimate        s.e.     parameter
[o]     1      -0.3698       7.027     LCCO
[o]     2        2.131       26.04     CAT(1)
[o]     3        6.835       23.30     CAT(2)
[o]     4       -10.16       10.25     ACT(2)
[o]     5       0.9148       7.034     ACT(3)
[o]     6        2.713       52.16     ACT(4)
[o]     scale parameter taken as  31.36
[o]
```

```
[i] ? !nothing is significant
[i] ? !There is no relationship between surface samples for Fel d 1 and air
[i] ? !sample concentrations of Fel d 1 in this data set, even when high
[i] ? !activity and presence of a cat are taken into account
[i] ? $stop$
```